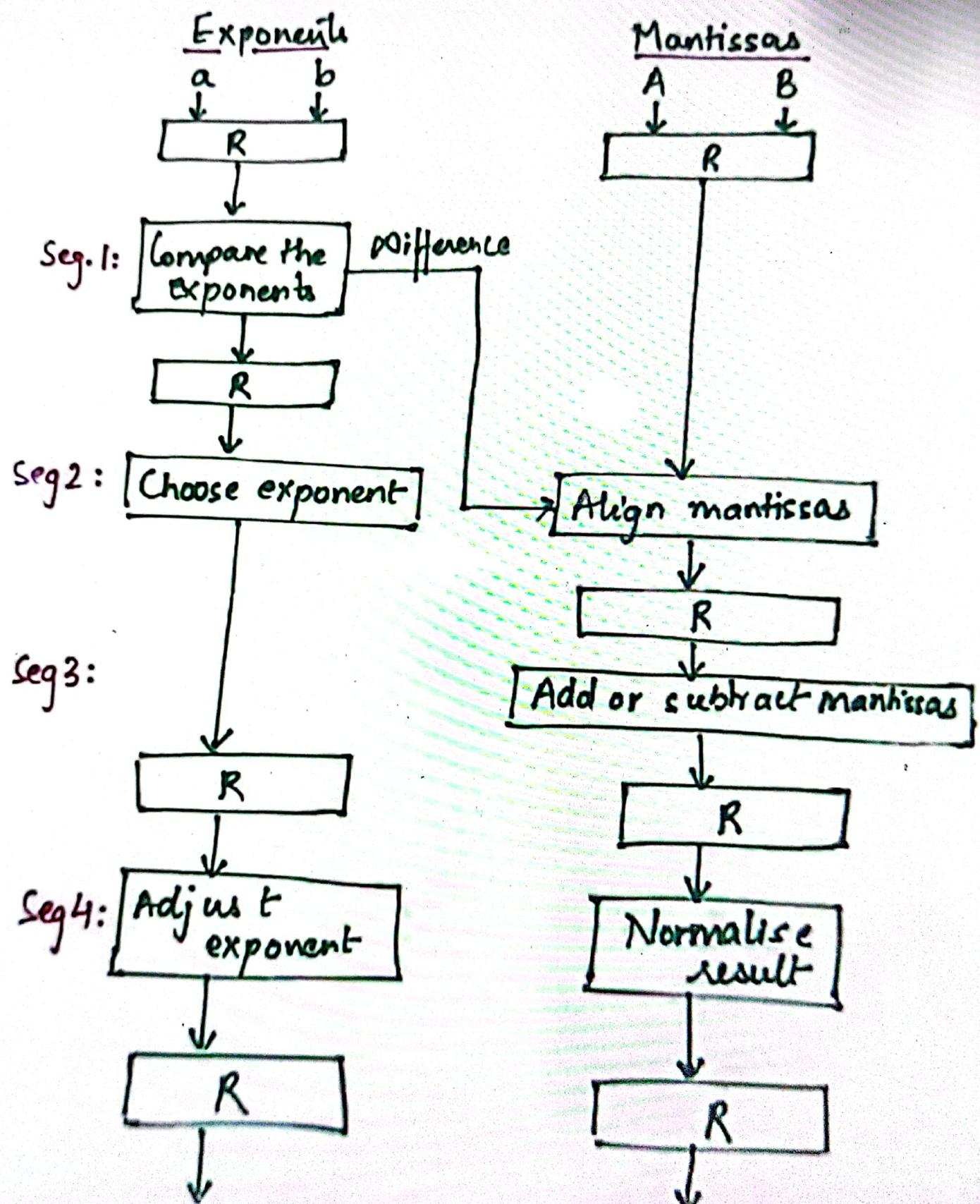


## Arithmetic Pipeline



- ① Compare the powers
- ② Align the manissas
- ③ Add or sub.
- ④ Normalise result.

$$x = 0.9504 \times 10^{\textcircled{3}} \quad \checkmark$$

$$y = 0.8200 \times 10^{\textcircled{2}}$$

→

$$\begin{cases} x = 0.9504 \times 10^{-3} \\ y = 0.0820 \times 10^{-3} \end{cases}$$

$$z = 1.0324 \times 10^{-3}$$

$$z = 0.10324 \times 10^{-4}$$

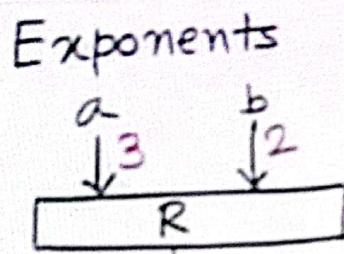
Seg 3

Seg 4

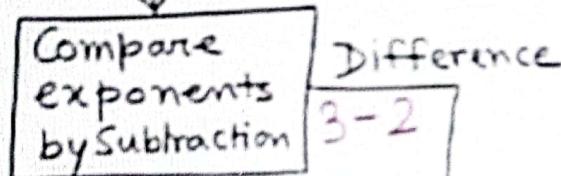
## Arithmetic Pipeline

$$\times 10^a$$

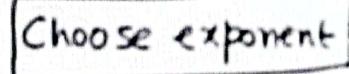
$$\times 10^b$$



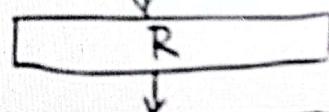
Segment 1



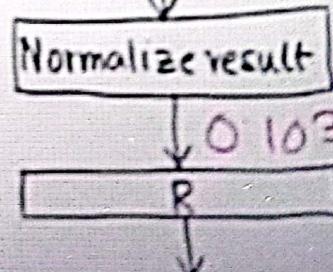
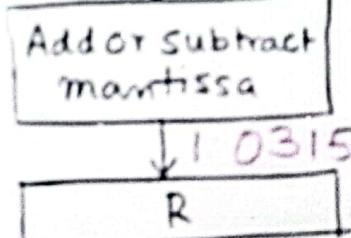
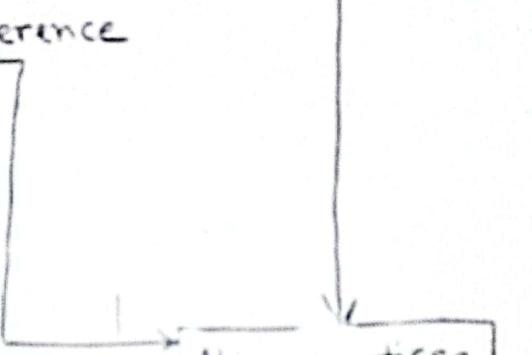
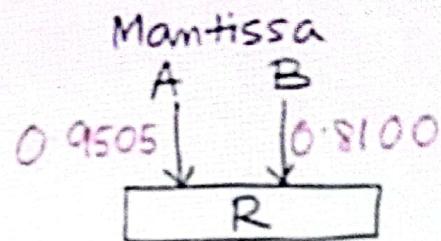
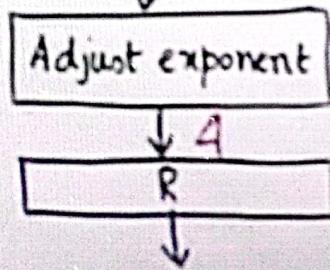
Segment 2



Segment 3



Segment 4



$$Y = 0.9505 \times 10^3 = A \times 10^6$$
$$Y = 0.8100 \times 10^2 = B \times 10^6$$
$$= 0.0810 \times 10^3$$

$$Z = X + Y$$
$$= 1.0315 \times 10^3$$
$$= 0.10315 \times 10^4$$

Steps	1	2	3	4	5	6	7	8	9	10	11	12	13
Instruction	IF	ID	OF	EX									
(Branch)	2	IF	ID	OF	EX								
	3		IF	ID	OF	EX							
	4			IF	-	-	IF	ID	OF	EX			
	5				-	-	-	IF	ID	OF	EX		
	6					-	-	-	IF	ID	OF	EX	
	7						-	-	-	IF	ID	OF	EX

## Timing of Instruction Pipeline

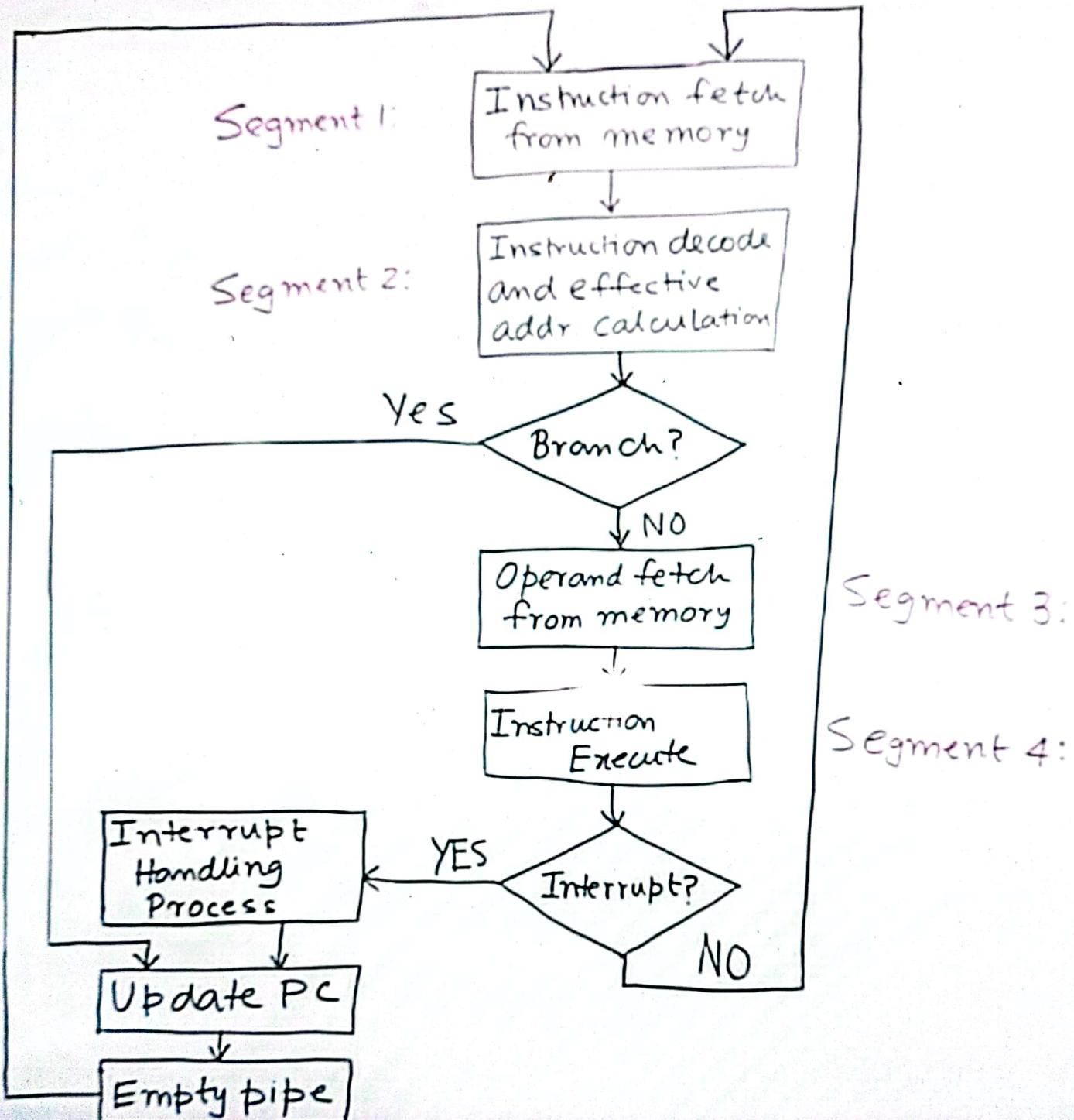
IF  $\Rightarrow$  Instruction Fetch

ID  $\Rightarrow$  Instruction Decode

OF  $\Rightarrow$  Operand Fetch

EX  $\Rightarrow$  Execute

# Pipeline Architecture : Instruction Pipeline



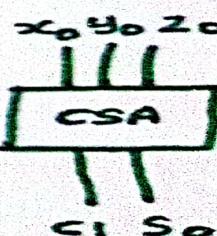
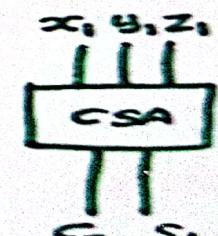
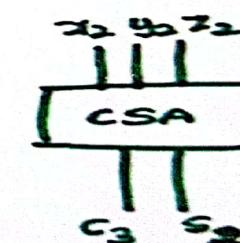
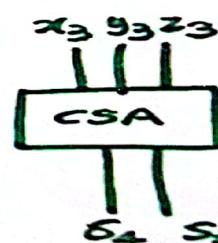
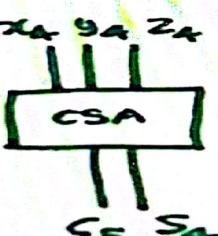
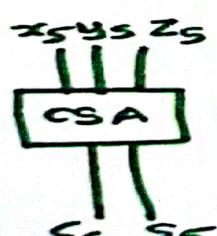
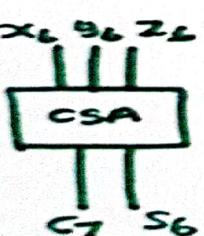
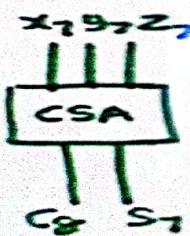
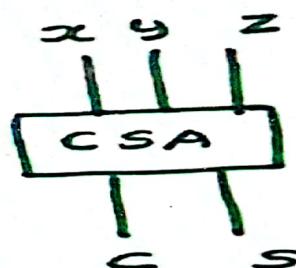
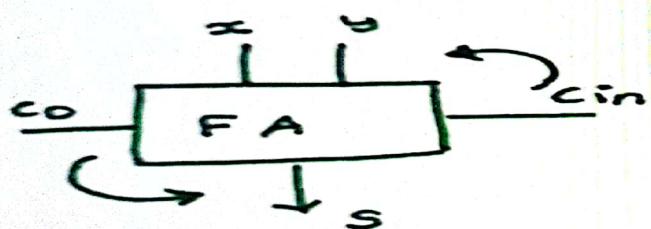
$$\begin{array}{r}
 \text{CARRY :} & 0 & 1 & 1 \\
 x = & 1 & 4 & 7 & 2 & 1 \\
 y = & 8 & 2 & 1 & 3 & 6 \\
 z = & 4 & 3 & 0 & 5 & 9 \\
 \hline
 & 1 & 3 & 9 & 9 & 1 & 6
 \end{array}$$

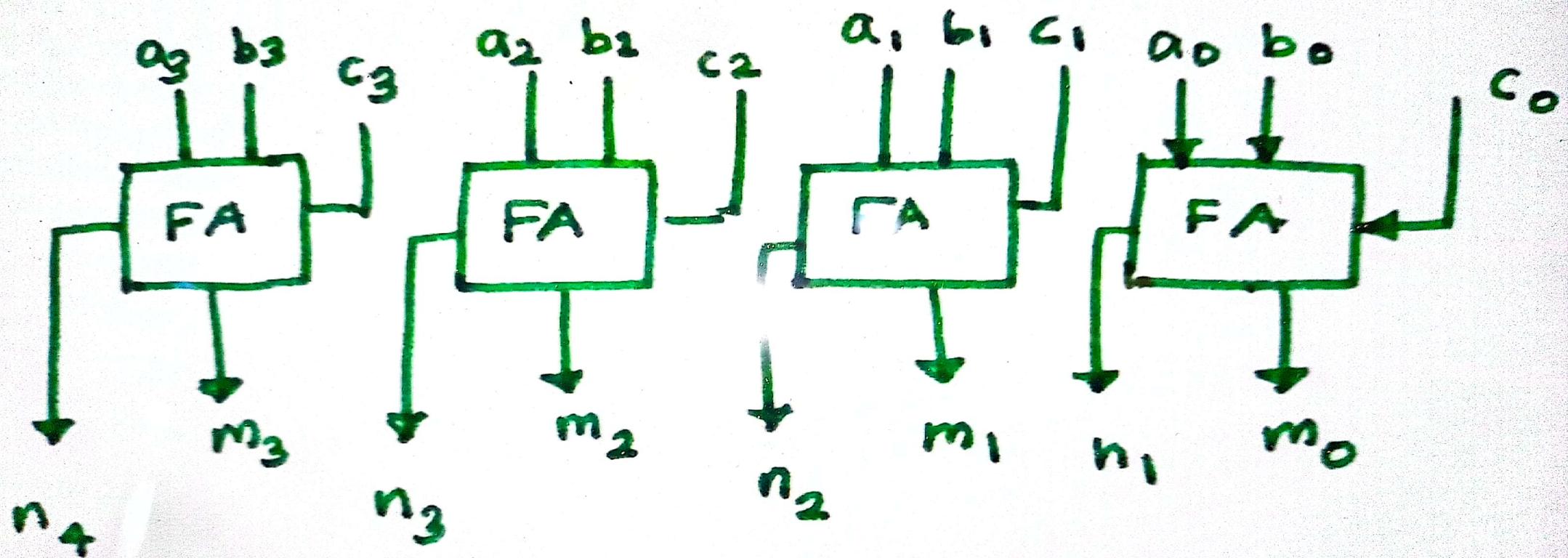
$$\begin{array}{r}
 x = 1 & 4 & 7 & 2 & 1 \\
 y = 8 & 2 & 1 & 3 & 6 \\
 z = 4 & 3 & 0 & 5 & 9 \\
 \hline
 \text{sum} = \underline{\quad} & 3 & 9 & 8 & 0 & 6
 \end{array}$$

$$\begin{array}{r}
 x = 1 & 4 & 7 & 2 & 1 \\
 y = 8 & 2 & 1 & 3 & 6 \\
 z = 4 & 3 & 0 & 5 & 9 \\
 \hline
 \text{carry} = \underline{\quad} & 1 & 0 & 0 & 1 & 1
 \end{array}$$

$$\begin{array}{r}
 \text{sum} = 3 & 9 & 8 & 0 & 6 \\
 \text{CARRY} = \underline{\quad} & 1 & 0 & 0 & 1 & 1 \\
 \hline
 & 1 & 3 & 9 & 9 & 1 & 6 \\
 \hline
 & & & & \underbrace{\quad}_{\text{sum}}
 \end{array}$$

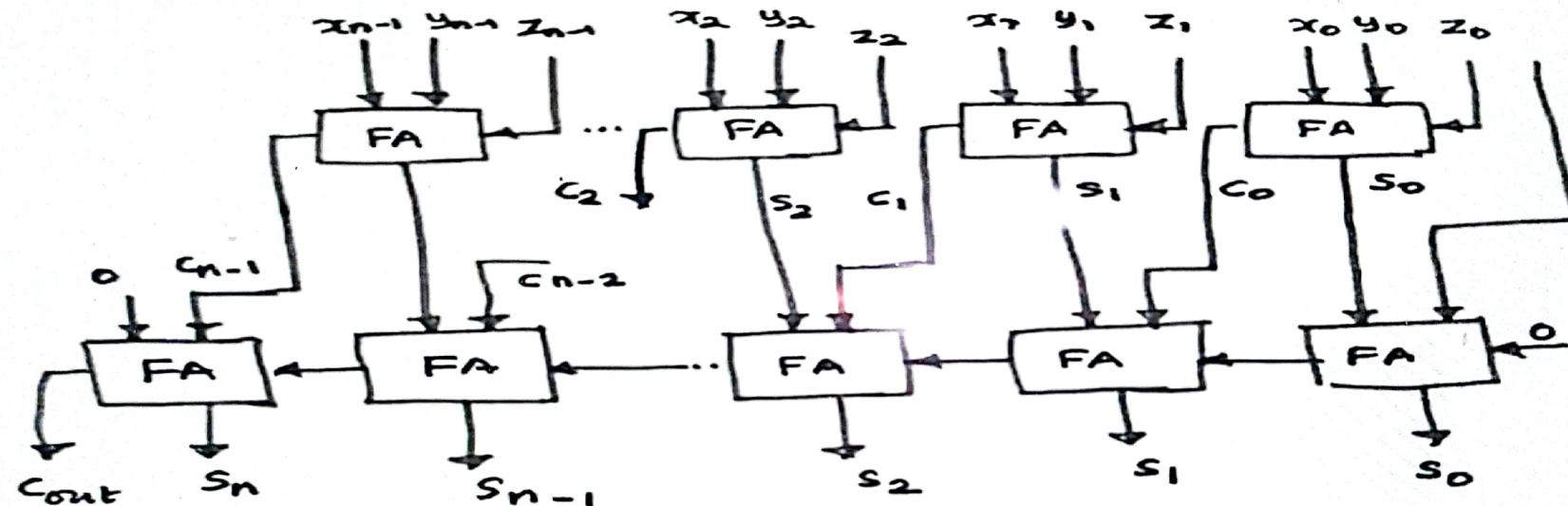
$$\begin{array}{r}
 x : 1 \ 0 \ 0 \ 1 \ 1 \\
 y : 1 \ 1 \ 0 \ 0 \ 1 \\
 z : 0 \ 1 \ 0 \ 1 \ 1 \\
 \hline
 s : 0 \ 0 \ 0 \ 0 \ 1 \\
 c : 1 \ 1 \ 0 \ 1 \ 1 \\
 \hline
 \text{SUM} : 1 \ 1 \ 0 \ 1 \ 1
 \end{array}$$





# N-BIT CSA WITH CARRY IN

N BIT CSA WITH CARRY IN.



$$\begin{array}{r} & & & \text{Cin} \\ x_3 & x_2 & x_1 & x_0 & + \\ y_3 & y_2 & y_1 & y_0 & \\ z_3 & z_2 & z_1 & z_0 & \\ \hline s_3 & s_2 & s_1 & s_0 & \\ c_3 & c_2 & c_1 & c_0 & \text{Cin} \\ \hline s_4 & s_3 & s_2 & s_1 & s_0 \end{array}$$

$$\begin{array}{r}
 \text{carry:} & 1 & 1 & 2 & 1 \\
 \text{x:} & 1 & 2 & 3 & 4 & 5 \\
 \text{y:} & 3 & 8 & 1 & 7 & 2 \\
 \text{z:} & + & 2 & 0 & 5 & 8 & 7 \\
 \hline
 \text{sum:} & 7 & 1 & 0 & 4
 \end{array}$$

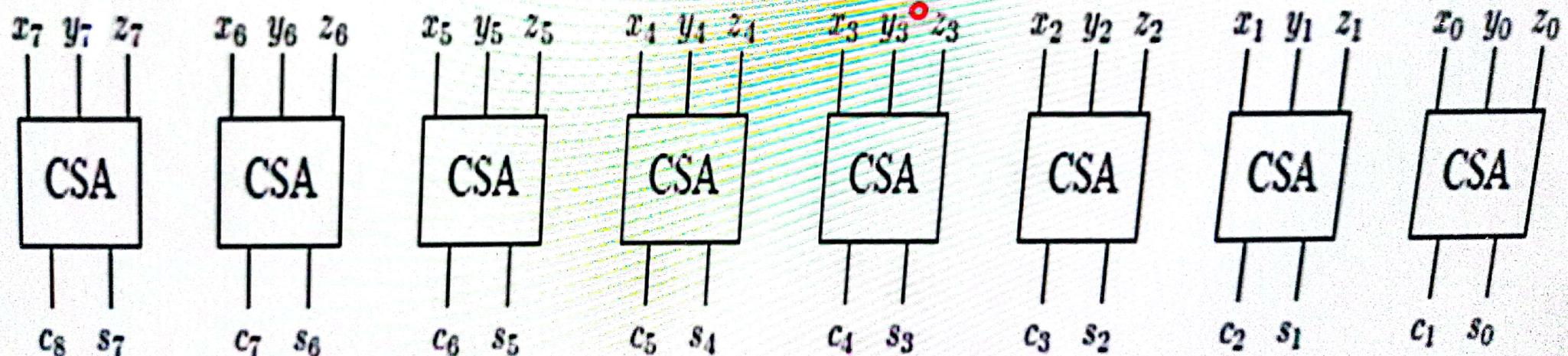
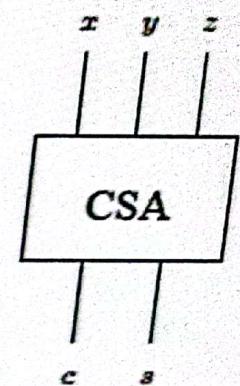
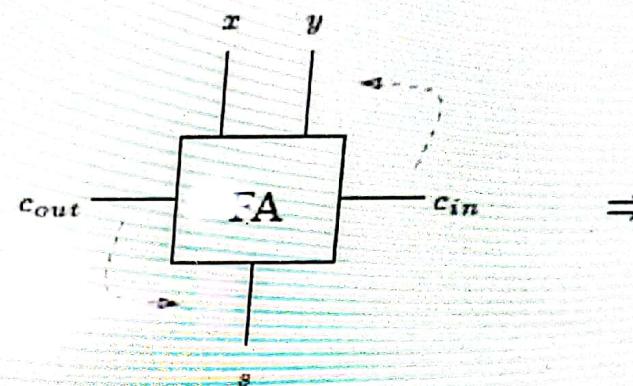
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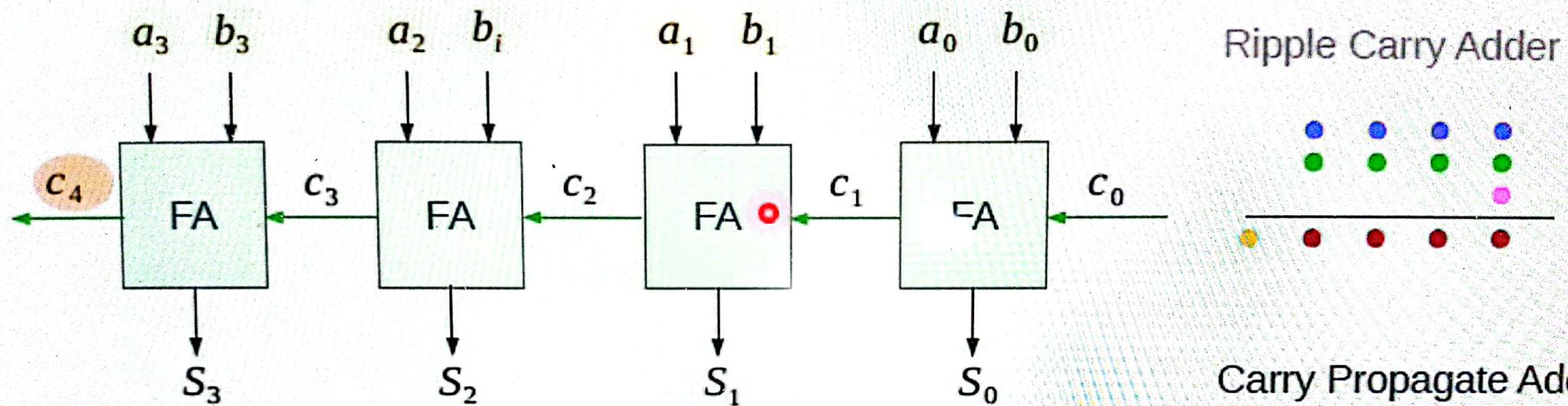
$$\begin{array}{r}
 \text{x:} & 1 & 2 & 3 & 4 & 5 \\
 \text{y:} & 3 & 8 & 1 & 7 & 2 \\
 \text{z:} & + & 2 & 0 & 5 & 8 & 7 \\
 \hline
 \text{s:} & 6 & 0 & 9 & 9 & 4
 \end{array}$$

$$\begin{array}{r}
 \text{x:} & 1 & 2 & 3 & 4 & 5 \\
 \text{y:} & 3 & 8 & 1 & 7 & 2 \\
 \text{z:} & + & 2 & 0 & 5 & 8 & 7 \\
 \hline
 \text{c:} & 1 & 0 & 1 & 1
 \end{array}$$

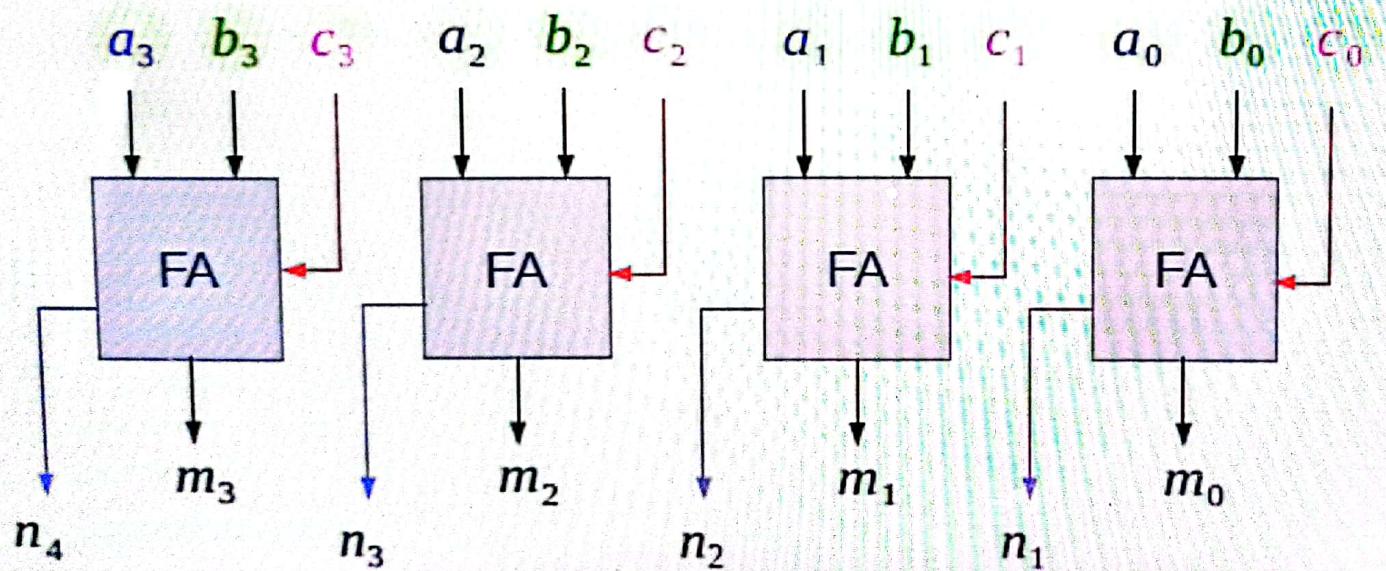
$$\begin{array}{r}
 \text{s:} & 6 & 0 & 9 & 9 & 4 \\
 \text{c:} & + & 1 & 0 & 1 & 1 \\
 \hline
 \text{sum:} & 7 & 1 & 1 & 0 & 4
 \end{array}$$

$$\begin{array}{r}
 \begin{array}{r}
 x: & 1 & 0 & 0 & 1 & 1 \\
 y: & 1 & 1 & 0 & 0 & 1 \\
 z: + & 0 & 1 & 0 & 1 & 1 \\
 \hline
 s: & 0 & 0 & 0 & 0 & 1 \\
 c: + & 1 & 1 & 0 & 1 & 1 \\
 \hline
 \text{sum:} & 1 & 1 & 0 & 1 & 1
 \end{array}
 \end{array}$$

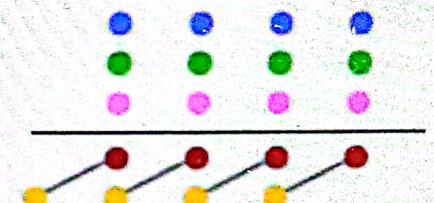


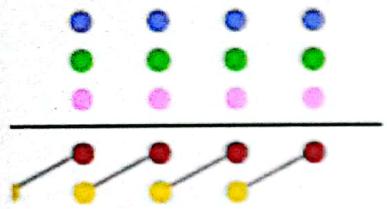


Carry Propagate Adder



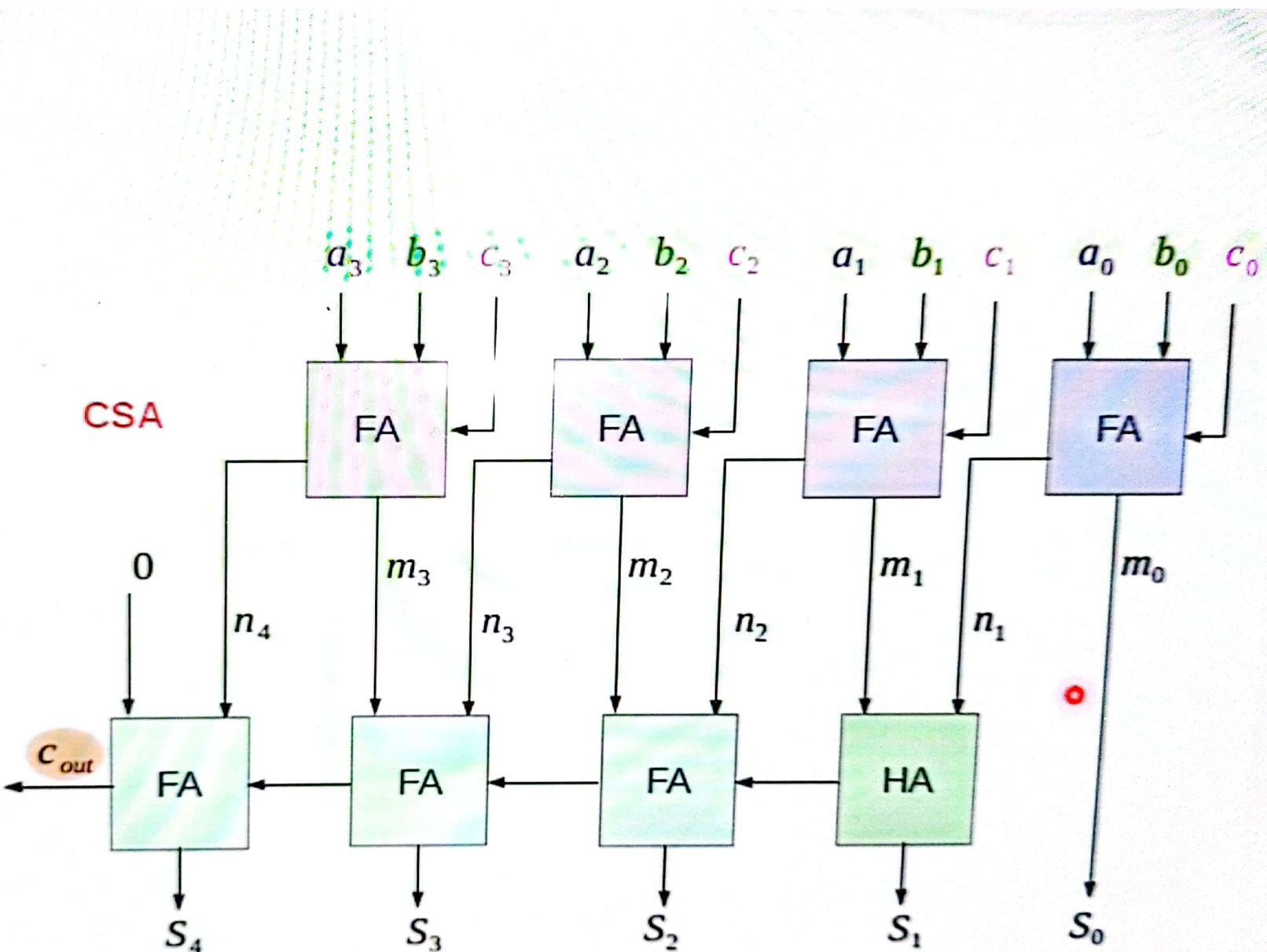
Carry Save Adder

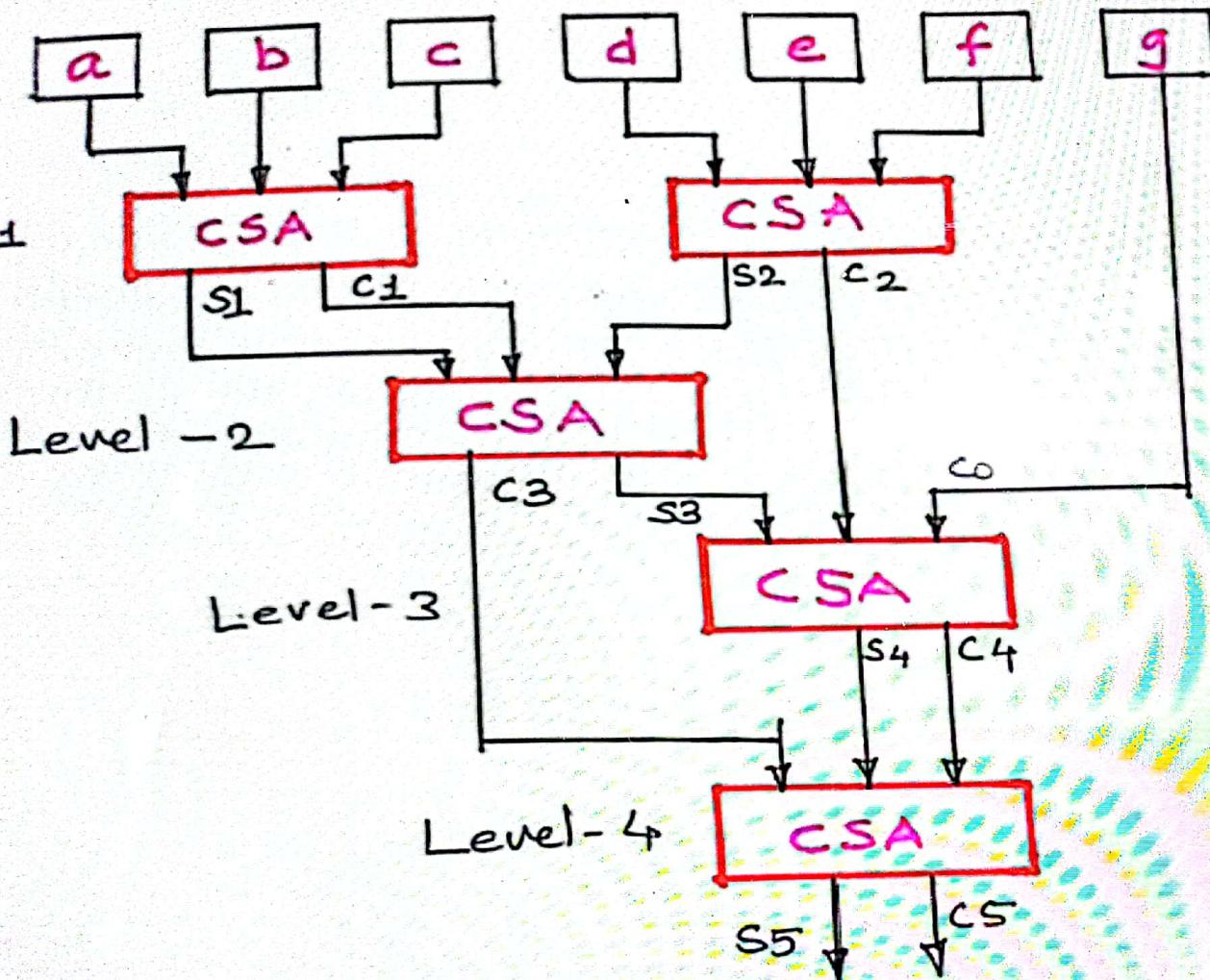




**CSA**

**CPA**  
(RCA, etc.)





7  $n$ -bit binary nos.

a  $a_{n-1} a_{n-2} \dots a_2 a_1 a_0$

b  $b_{n-1} b_{n-2} \dots b_2 b_1 b_0$

c  $c_{n-1} c_{n-2} \dots c_2 c_1 c_0$

d  $d_{n-1} d_{n-2} \dots d_2 d_1 d_0$

e  $e_{n-1} e_{n-2} \dots e_2 e_1 e_0$

f  $f_{n-1} f_{n-2} \dots f_2 f_1 f_0$

g  $g_{n-1} g_{n-2} \dots g_2 g_1 g_0$