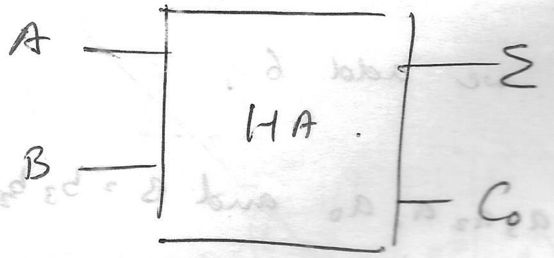
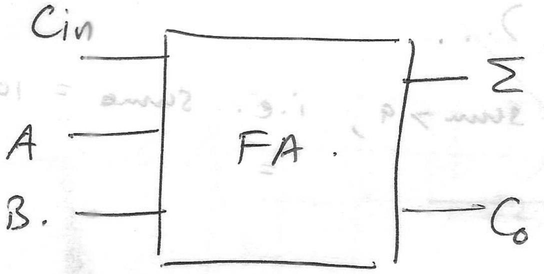
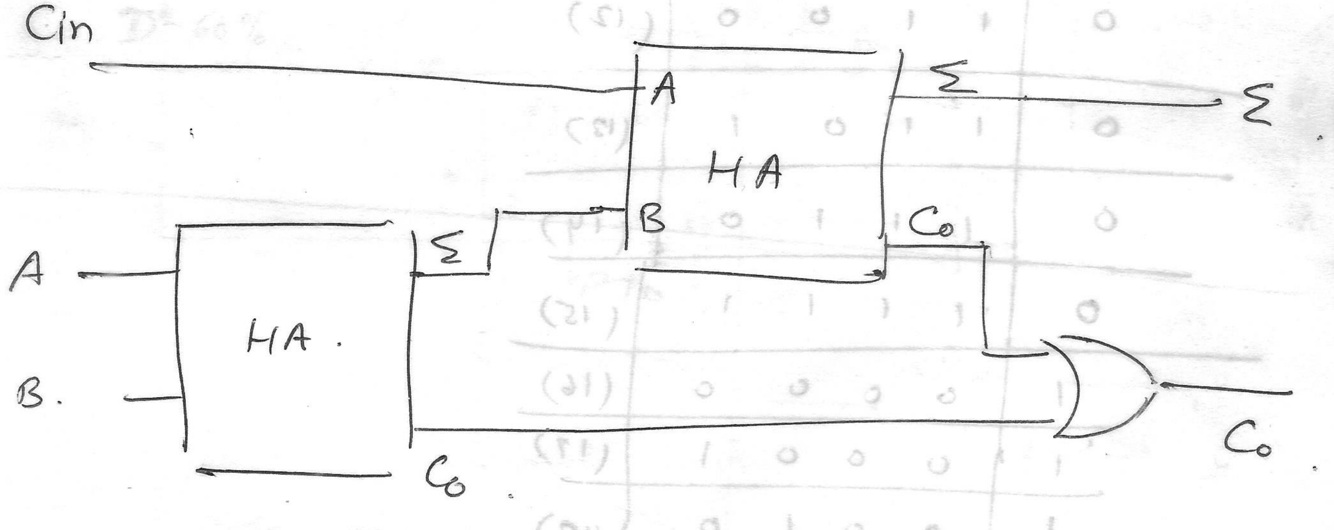
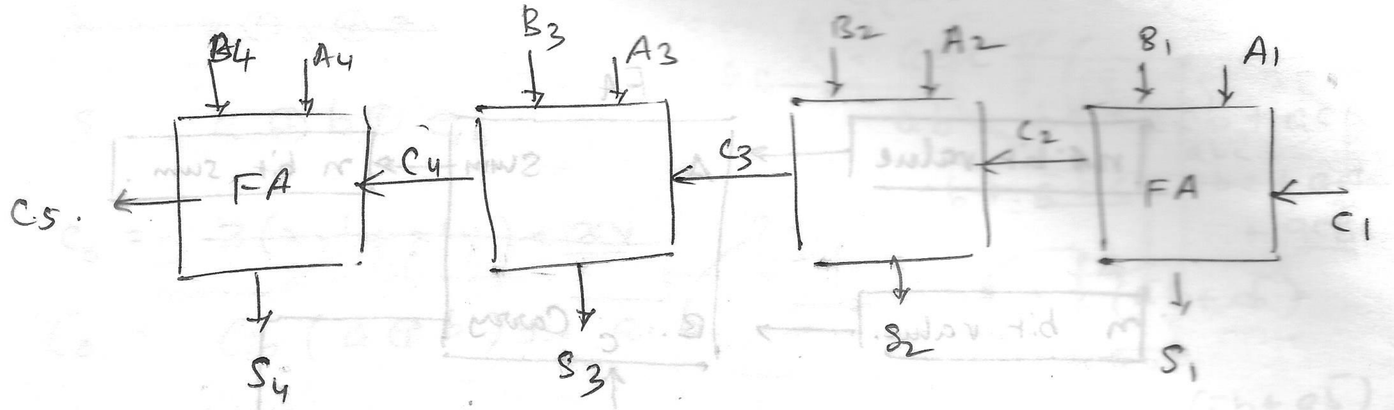

A
B
HA
Σ
Co


Cin
A
B
FA
Σ
Co


Cin
A
B
HA
Σ
Co
A
B
HA
Σ
Co
Σ
Co

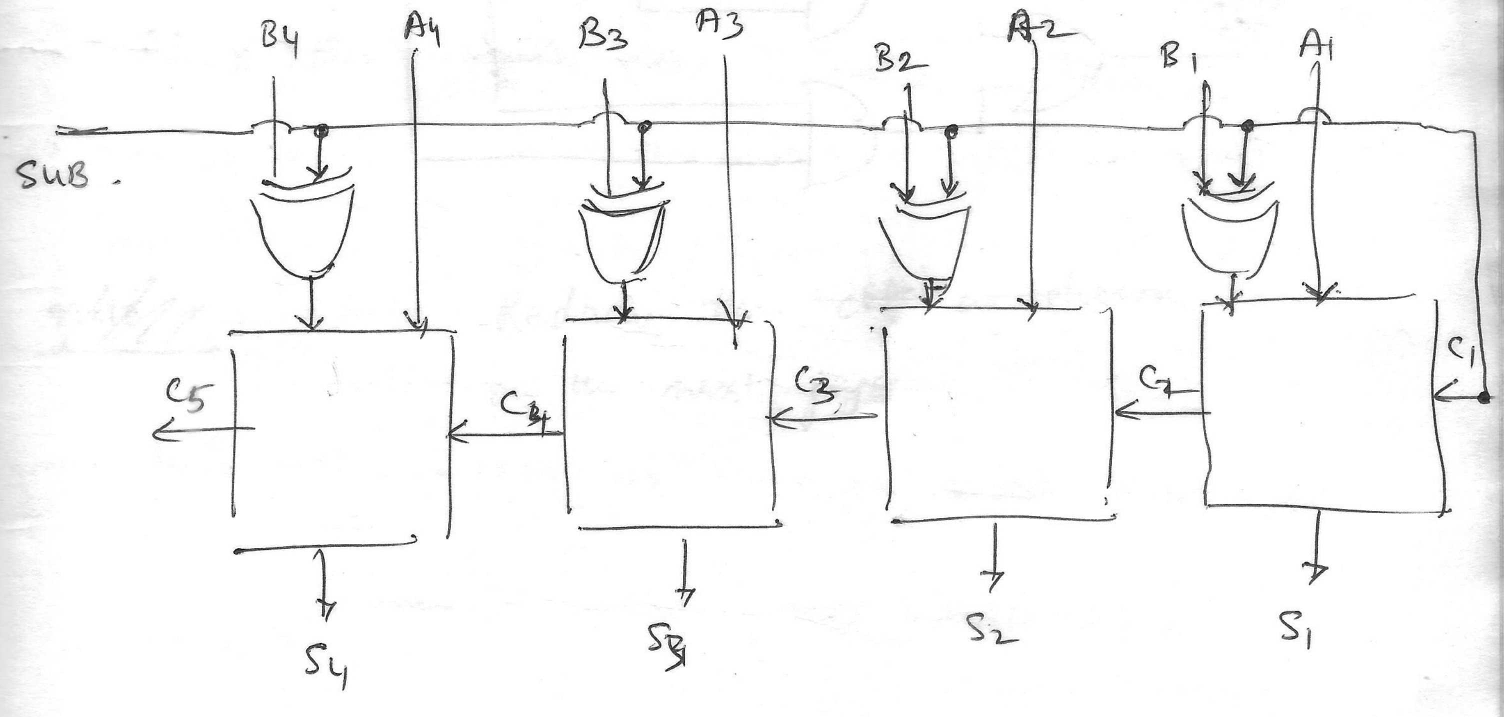
4-bit Binary Parallel Adder (Ripple Carry Adder)



In general,
An n-bit adder requires ~~n~~ full adders.
Propagation delay = $n \times (FA_{delay})$.

∴ 32 bit adder ⇒ 32 cycles!

4 bit Binary Adder - Subtractor

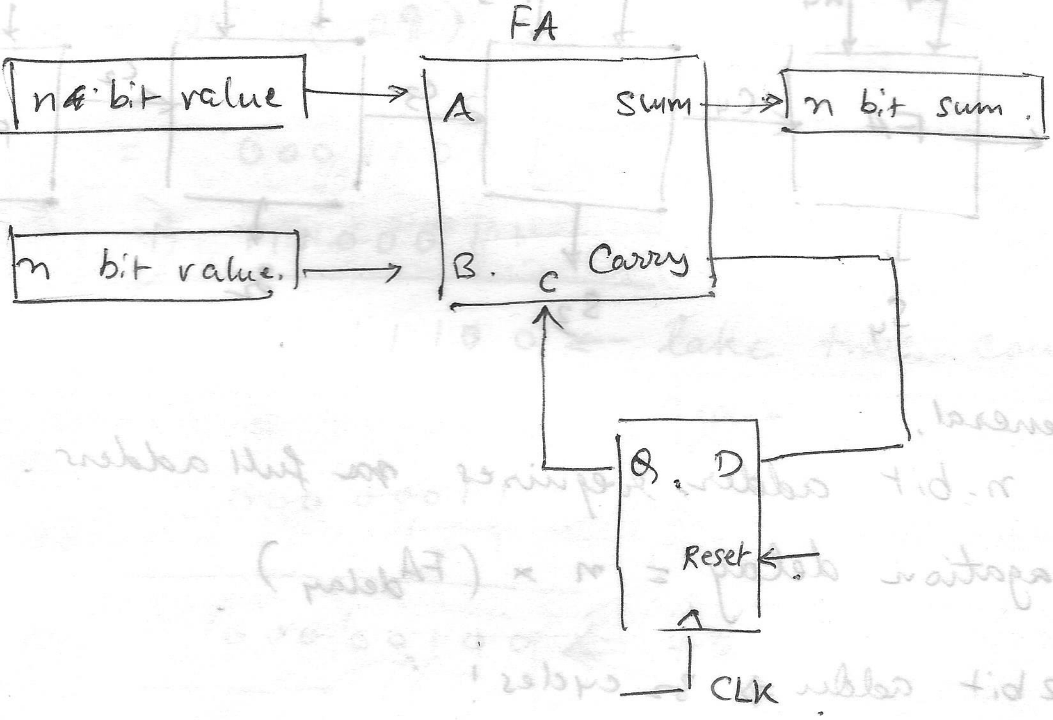


SUB = 0 ⇒ Adder.

SUB = 1 ⇒ Subtractor.

020 - 40197216.

Serial Adder



Review of Full Adder.

$ab + bc + ac(b+\bar{b})$

$\cancel{c(a\bar{b} + \bar{a}b)} + ab$

$= \cancel{\bar{a}\bar{b}c} +$

$ab + bc + acb + ac\bar{b}$

$= ab + \bar{a}bc + \cancel{abc} + \cancel{acb} + ac\bar{b}$

$= ab + c(\bar{a}b + a\bar{b})$

$+ abc$

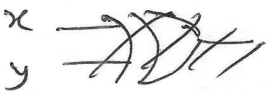
$= ab + c(\bar{a}b + a\bar{b})$

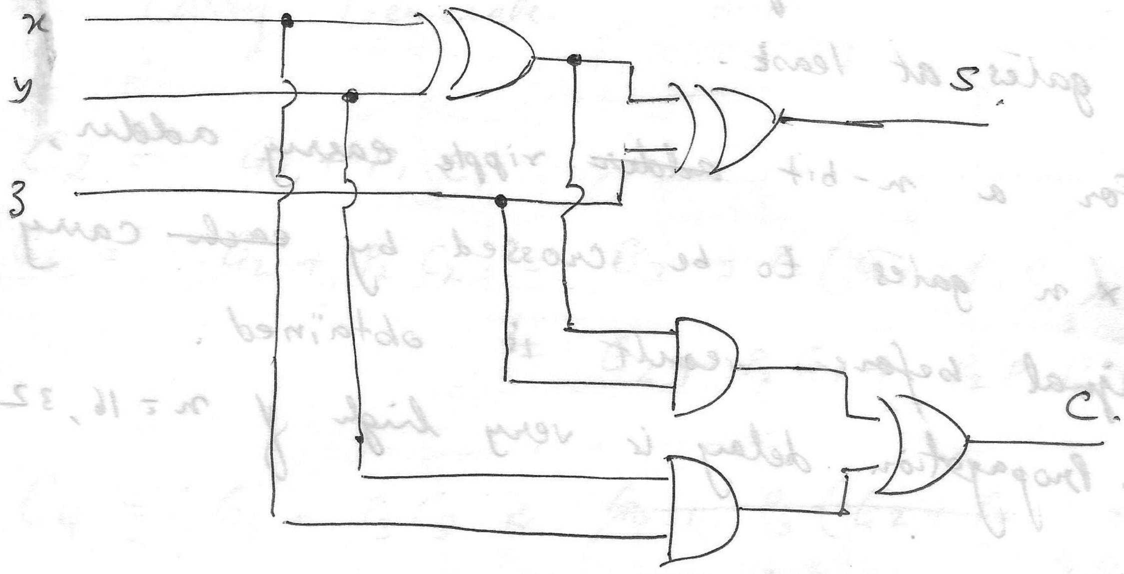
$\cancel{S = x \oplus y \oplus z}$

$S = a \oplus b \oplus c_{in}$.

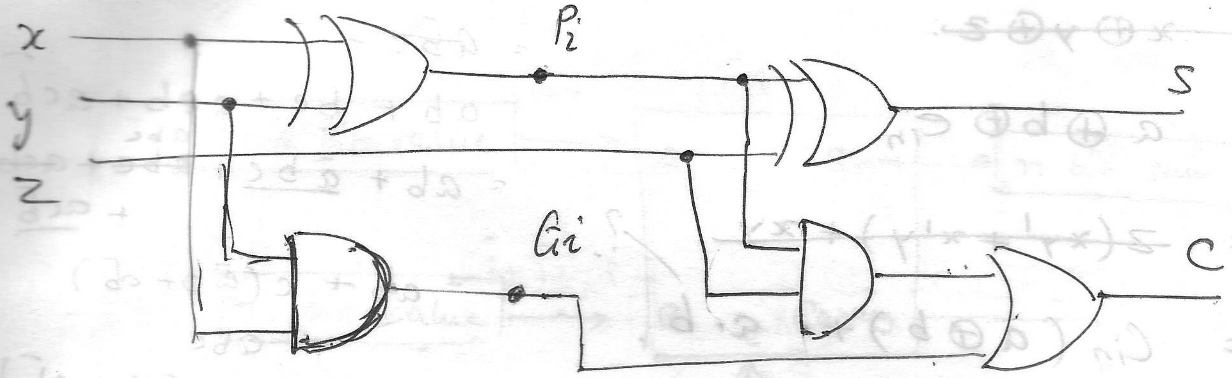
$\cancel{C_o = z(xy' + x'y) + xy}$?

$C_o = C_{in}(a \oplus b) + a \cdot b$.





~~Note~~ ! : Redraw this ckt as shown on the next page



∴ note :

1) For FA each signal has to go through two gates at least..

2) ∴ For a n-bit ~~adder~~ ripple carry adder, $2 \times n$ gates to be crossed by ~~each~~ carry signal before result is obtained.

∴ Propagation delay is very high if $n = 16, 32$ et

Ig:

Ripple Carry Adder :

1) $2 \times n$ prog delay.
2) Each ~~carry~~ o/p depends on previous sum and ca

∴ Look-ahead carry adder is used.

Let us define

$P_i = A_i \oplus B_i$, where A_i and B_i are the ith bits in an n-bit number to be added.

Simil

$$G_i = A_i \cdot B_i$$

$$\therefore \; S_i = A_i \oplus B_i \oplus C_i = P_i \oplus C_i$$

$$C_{i+1} = G_i + P_i C_i$$

P_i = ~~cas~~ carry propagate

G_i = Carry Generate

$$C_2 = G_1 + P_1 C_1$$

$$C_3 = G_2 + P_2 C_2 = G_2 + P_2(G_1 + P_1 C_1)$$

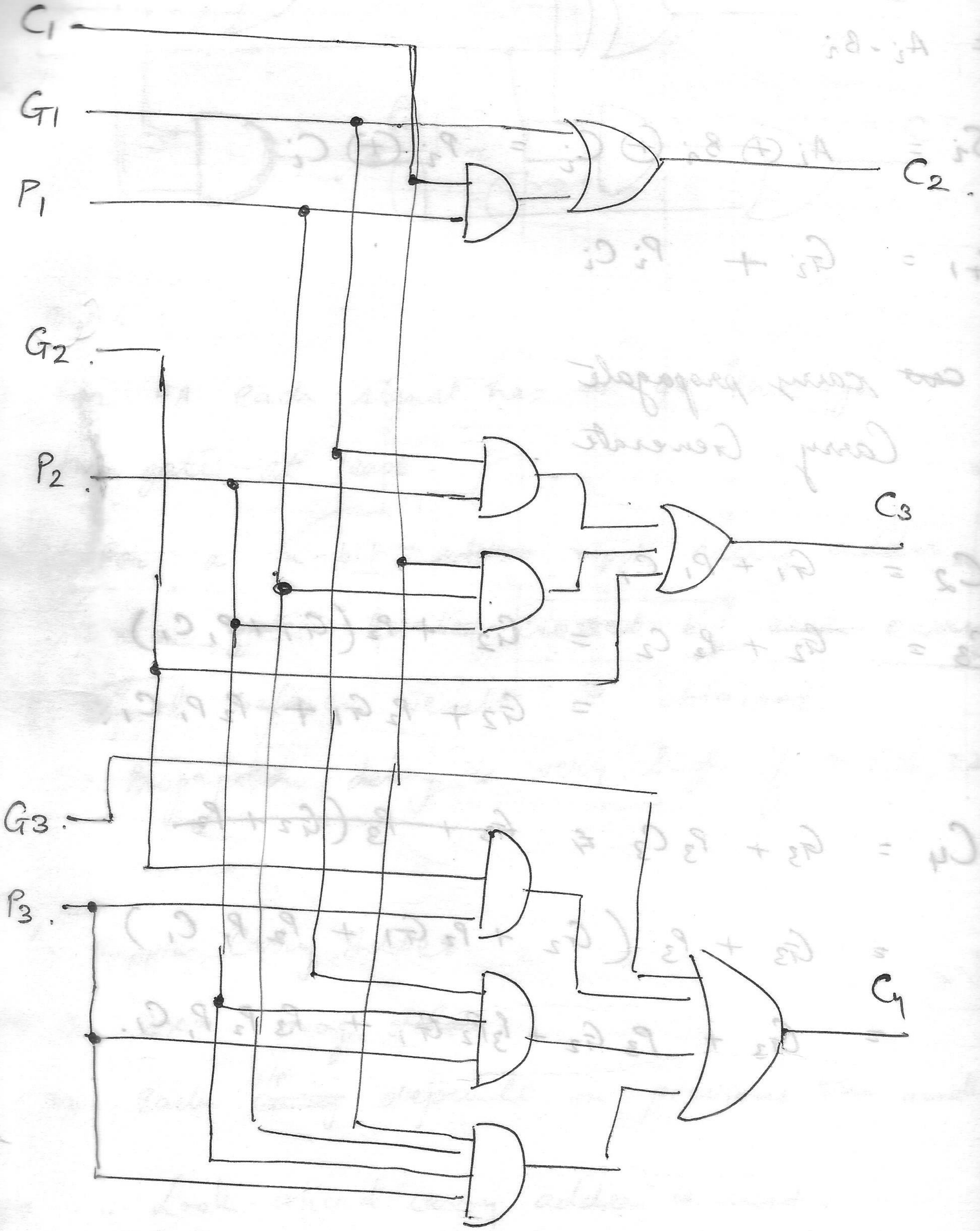
$$= G_2 + P_2 G_1 + P_2 P_1 C_1.$$

$$C_4 = G_3 + P_3 C_3 \cancel{=} \cancel{G_3 + P_3 (G_2 + P_2}$$

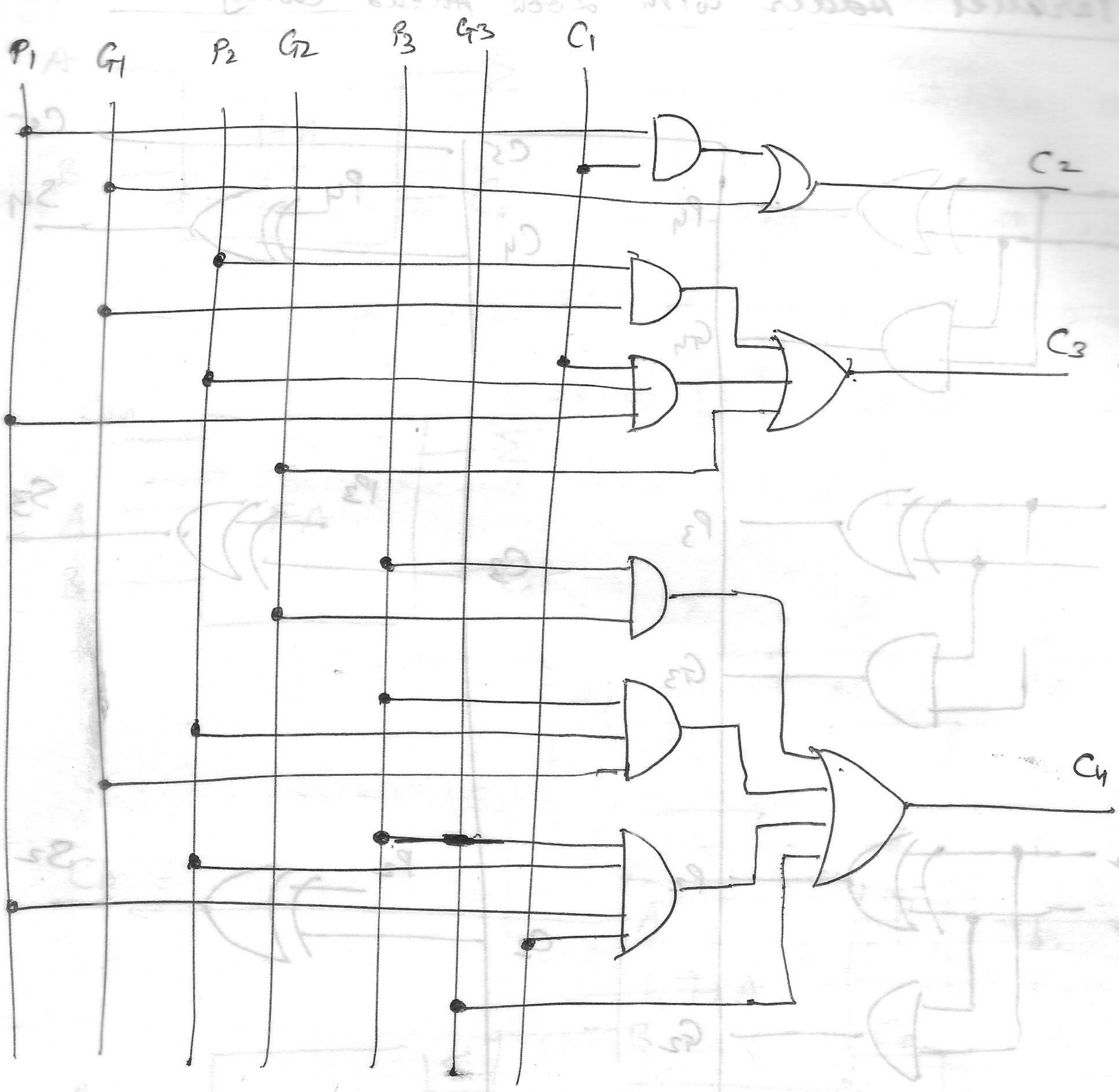
$$= G_3 + P_3 (G_2 + P_2 G_1 + P_2 P_1 C_1)$$

$$= G_3 + P_3 G_2 + P_3 P_2 G_1 + P_3 P_2 P_1 C_1.$$

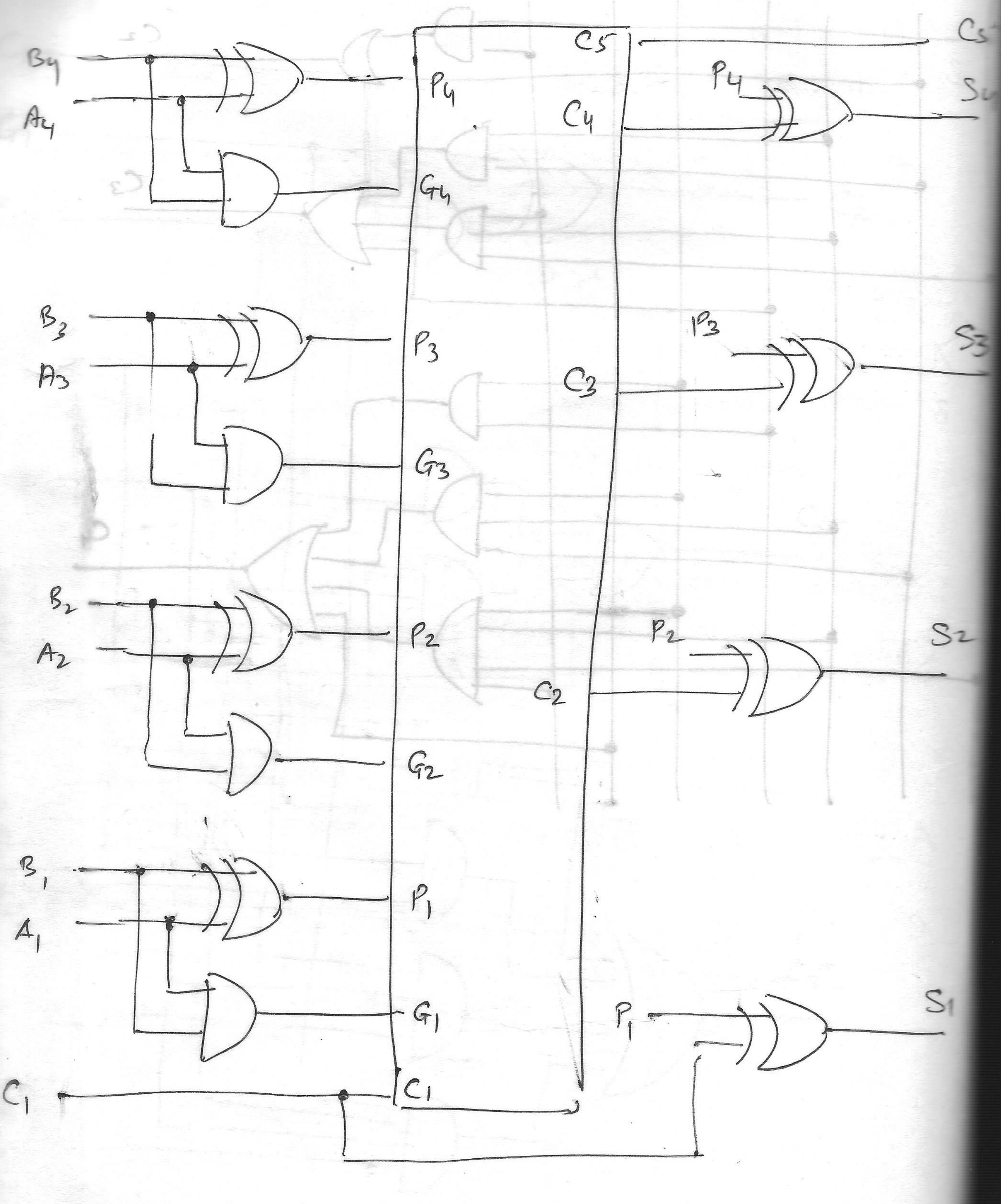
4 - bit ~~Parallel adder with~~ look - ahead carry



Redraw.



4 bit Parallel Adder with Look Ahead Carry



BCD Adder

- BCD addition : if sum > 9 we add 6.

Take two 4 bit nos. $A = a_3 a_2 a_1 a_0$ and $B = b_3 b_2$

$A = 0$ to 9, $B = 0$ to 9. ($\because$ BCD)

$A + B = 0$ to 18 (10010).

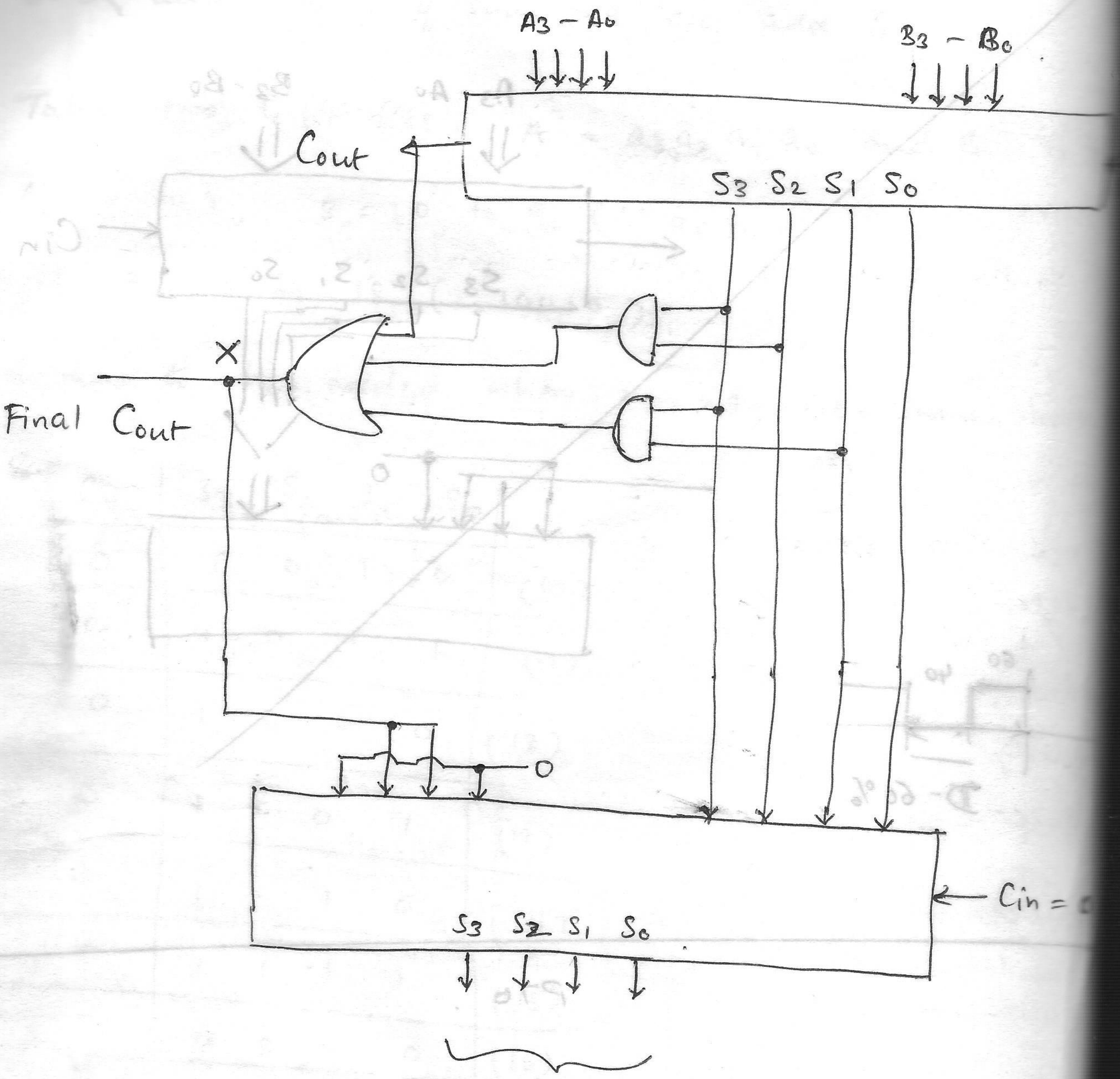
6 has to be added when sum > 9, i.e. sum = 10 -

C_4	S_3	S_2	S_1	S_0	
0	1	0	1	0	(10)
0	1	0	1	1	(11)
0	1	1	0	0	(12)
0	1	1	0	1	(13)
0	1	1	1	0	(14)
0	1	1	1	1	(15)
1	0	0	0	0	(16)
1	0	0	0	1	(17)
1	0	0	1	0	(18)

$\therefore \quad X = C_4 + S_3 (S_2 + S_1)$

See diagram on next page

Block Diagram of BCD Adder.



Final Sum.