* BCD Adder:

Design 4-bit BCD adder

Combinational ckt which adds two decimal digits in BCD form, together with an i/p carry from a previous stage.

Step 1: No. of i/ps = 2 decimal digits

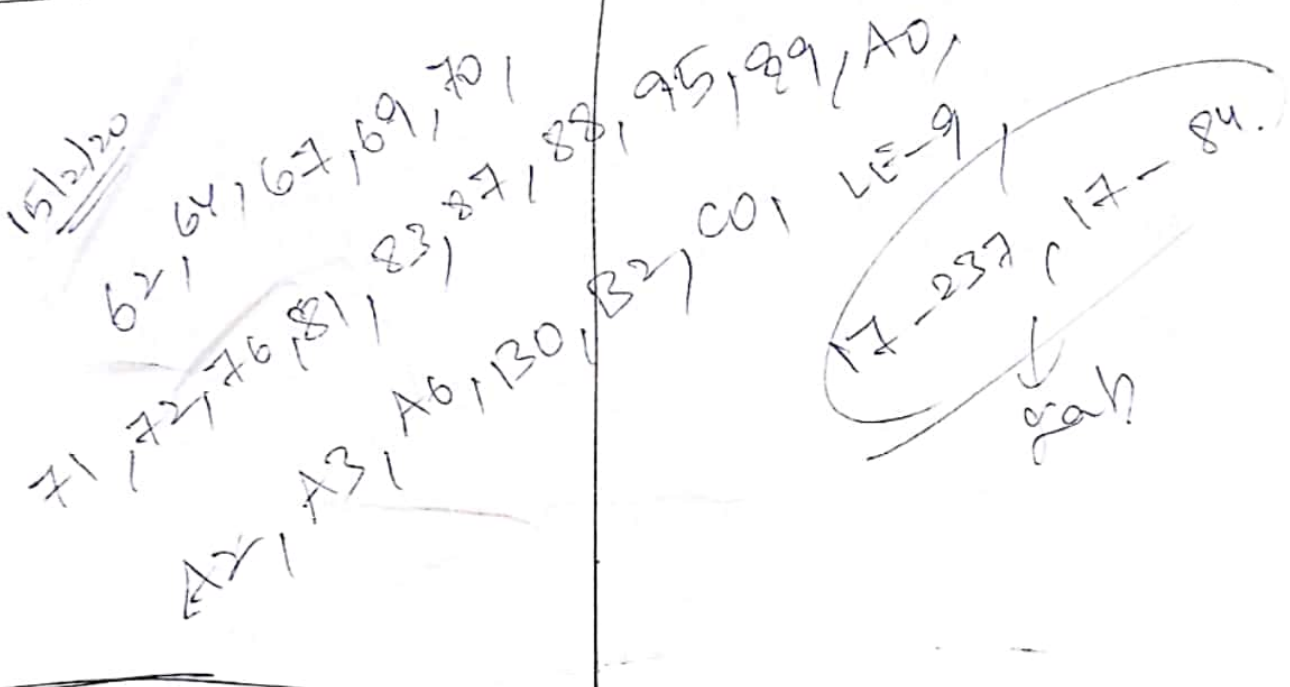
or

9 bits < 4 bits each from 2 decimal nos.
< 1 bit from prev carry

No. of o/ps = 4 S_8, S_4, S_2, S_1

Step 2: Truth table

Each i/p digit does not exceed 9, the o/p sum cannot be greater than
$9+9+1=19$
↳ i/p carry



Case(i): Total is less than or equal to 9

Eg:
$$\begin{array}{rr} 1 & \rightarrow 0001 \\ +5 & \rightarrow 0101 \\ \hline 6 & 0110 \end{array}$$

Up to 9 → Both BCD ~~addition~~ & Binary are going to be same

Case (ii): Total > 9

Ex:

	Binary
5	0101
6	0110
11	1011 → 11

BCD

$$\begin{array}{r} 0101 \\ 0110 \\ \hline 1011 \\ +0110 \\ \hline 0001 \end{array}$$

... 1 | 0001
(1)

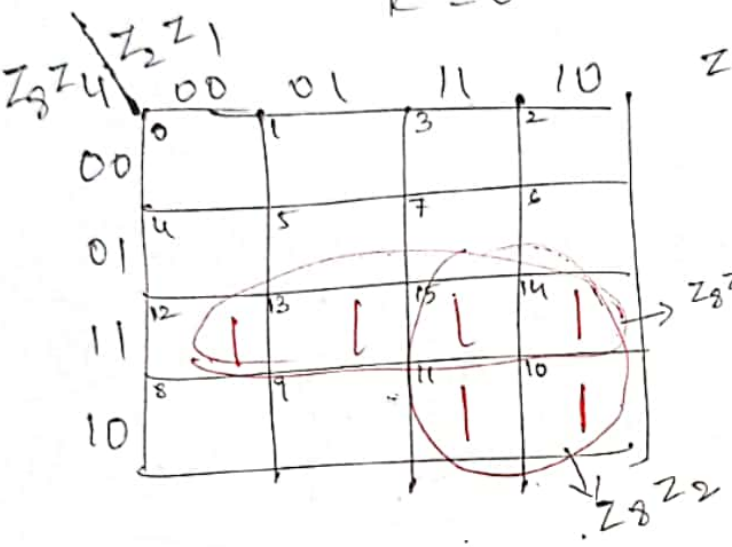
If value is > 9 ie; 1001 ⇒ add 0110 to that value.

Binary Sum					BCD Sum					Decimal
K	Z_8	Z_4	Z_2	Z_1	C	S_8	S_4	S_2	S_1	
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	0	1	1
0	0	0	1	0	0	0	0	1	0	2
0	0	0	1	1	0	0	0	1	1	3
0	0	1	0	0	0	0	1	0	0	4
0	0	1	0	1	0	0	1	0	1	5
0	0	1	1	0	0	0	1	1	0	6
0	0	1	1	1	0	0	1	1	1	7
0	1	0	0	0	0	1	0	0	0	8
0	1	0	0	1	0	1	0	0	1	9
0	1	0	1	0	1	0	0	0	0	10
0	1	0	1	1	1	0	0	0	1	11
0	1	1	0	0	1	0	0	1	0	12
0	1	1	0	1	1	0	0	1	1	13
0	1	1	1	0	1	0	1	0	0	14
0	1	1	1	1	1	0	1	0	1	15
1	0	0	0	0	1	0	1	1	0	16
1	0	0	0	1	1	0	1	1	1	17
1	0	0	1	0	1	1	0	0	0	18
1	0	0	1	1	1	1	0	0	1	19

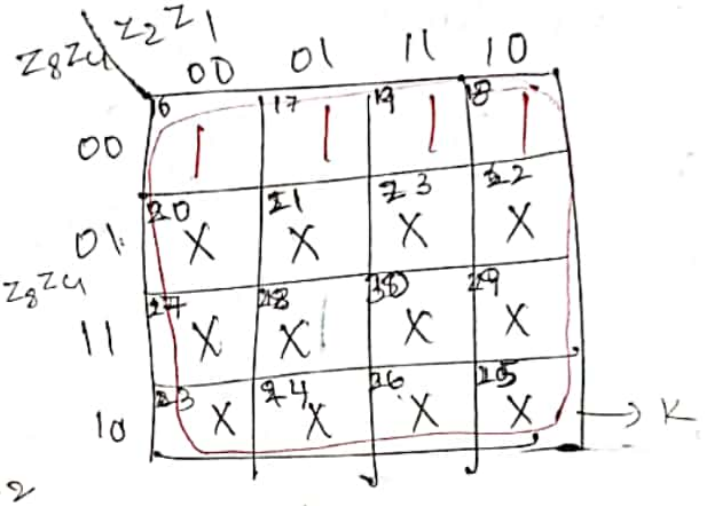
K Map for C

5-Variable K-Map

K = 0



K = 1



From 20 to 30 → don't care conditions.

$$C = K + Z_8Z_4 + Z_8Z_2$$

Step 4:

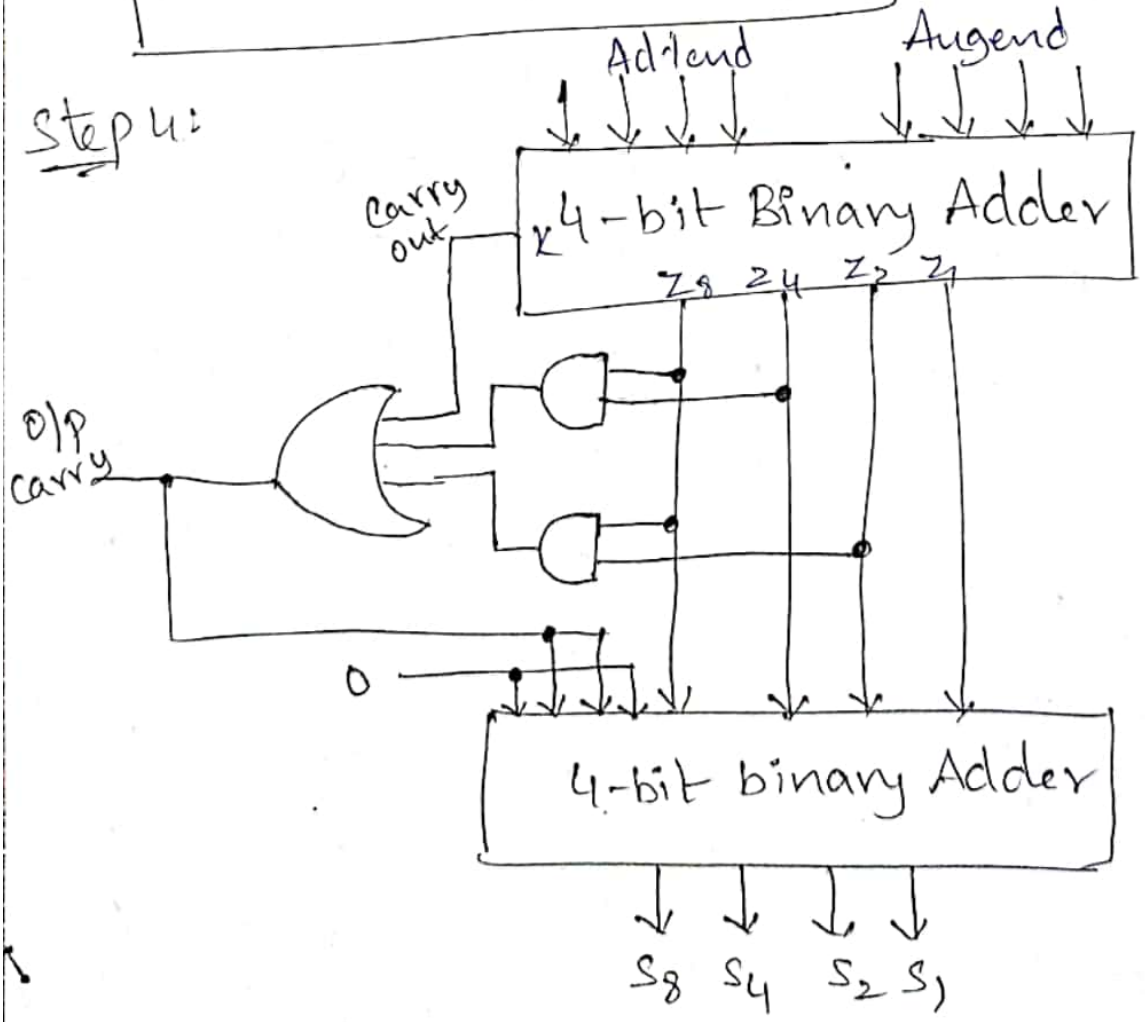


Fig: Block diagram of a BCD adder.