Paper 7, TDC Part-3
Chapter– 4, Combinational Logic Design
Lecture - 11

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Combinational Logic Design

Minimisation of Logic Functions Not specified in Minterms / Maxterms

Here we consider the cases where the functions are not specified in canonical forms. If the logic function is not specified in canonical form the we should 1st convert the logic function expression in canonical form. Then map the function into the K-map and minimised. Alternately, we can directly prepare K-map using the following algorithm:

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1. Enter ones for minterms and zeros for maxterms.
2. Enter a pair of ones/zeros for each of the terms with one variable less than the total number of variables.
3. Enter 4 adjacent ones/zeros for terms with two variable less than the total number of variables.
4. Repeat for other terms in the similar way.
5. Once the logical function is mapped into the K-map, the minimisation procedure is

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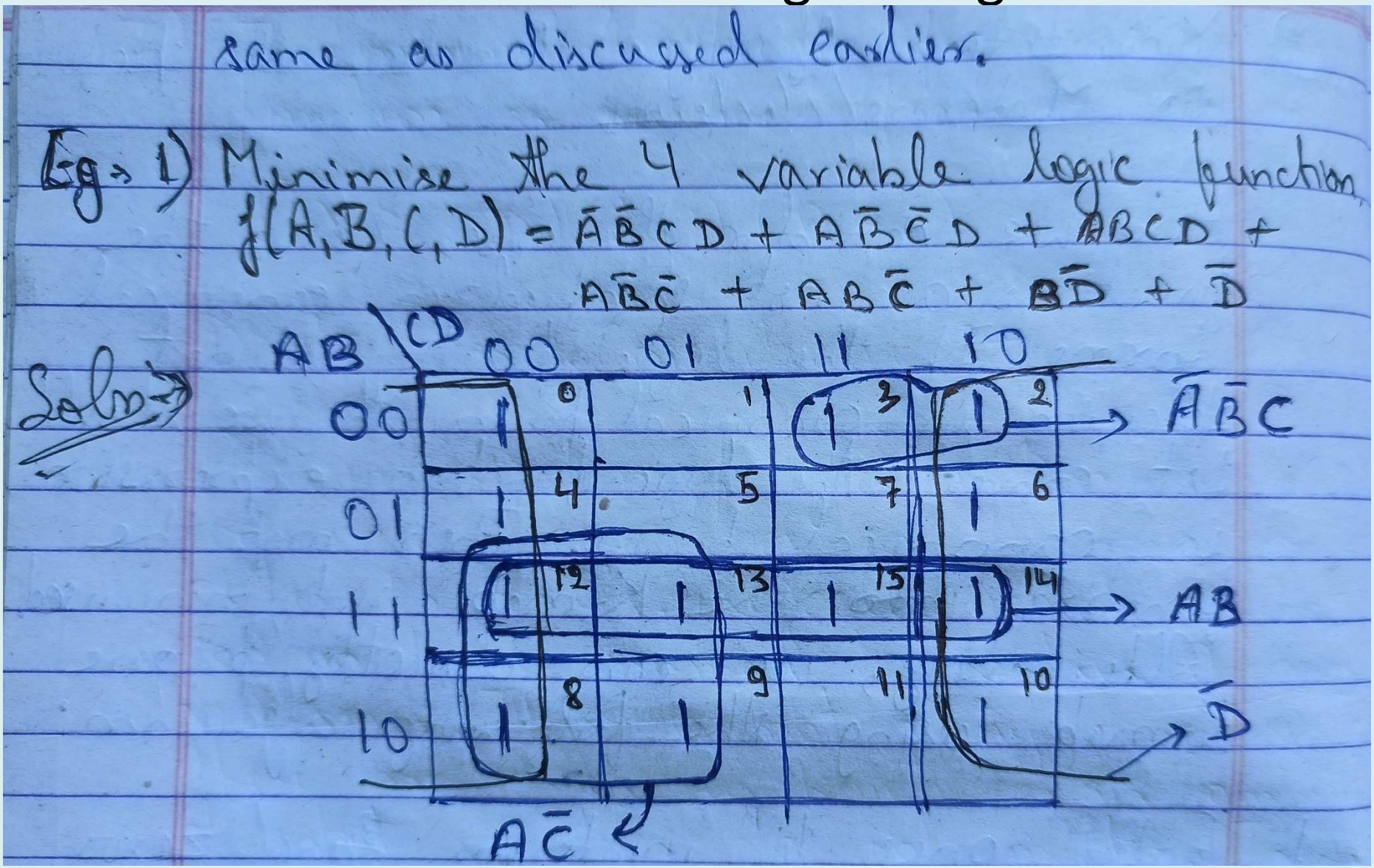

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$A\bar{C}$ ←

$\bar{A}\bar{B}CD$ corresponds to cell 0011 → 3

$A\bar{B}\bar{C}D$ " " 1001 → 9

$ABCD$ " " 1111 → 15

$A\bar{B}\bar{C}$ " n^2 cells 1000 & 1001

i.e. 8 & 9 resp.

$AB\bar{C}$ corresponds to 2 cells 1100 & 1101

i.e. 12 & 13 resp.

$B\bar{D}$ corresponds to 4 cells 0100, 0110, 1100 & 1110 i.e. 4, 6, 12 & 14 resp.

$\bar{D}$ corresponds to 8 cells 0000, 0010, 0100, 0110, 1000, 1010, 1100 & 1110

i.e. 0, 2, 4, 6, 8, 10, 12 & 14

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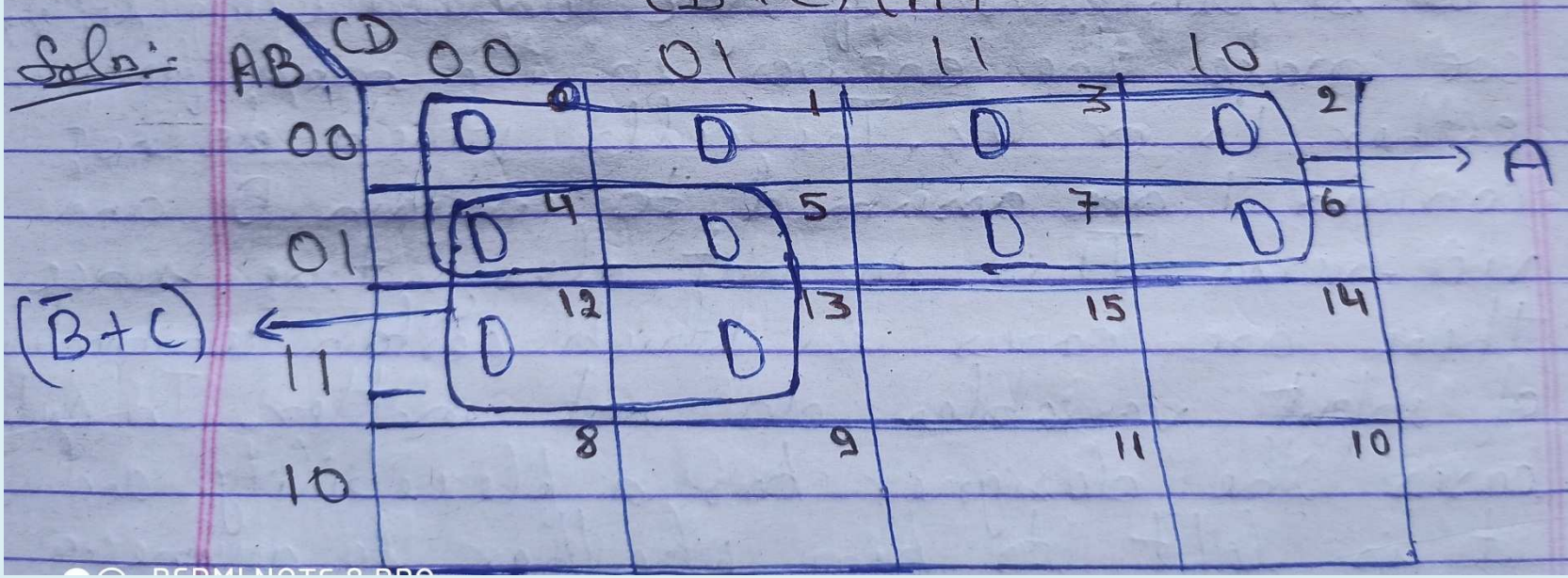
The minimized expression for the given logic function is,

$f(A,B,C,D) = \bar{A}\bar{B}C + AB + A\bar{C} + \bar{D}$

Eg→2 Minimise the 4 variable logic function.

$f(A,B,C,D) = (A+B+\bar{C}+\bar{D})(\bar{A}+\bar{B}+C)(A+B+\bar{D})(\bar{B}+C)(A)$

Soln:



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Maxterm $(A+B+\bar{C}+\bar{D})$ corresponds to cell 0011 → '3'

" $(\bar{A}+\bar{B}+C)$ corresponds to 2 cells '1100 & 1101' i.e. '12 & 13'

Maxterm $(A+B+\bar{D})$ corresponds to 2 cells '0001 & 0011' i.e. '1 & 3'

Maxterm $(\bar{B}+C)$ corresponds to 4 cells '0100, 0101, 1100 & 1101' i.e. '4, 5, 12 & 13'

Maxterm (A) corresponds to 8 cells '0000, 0001, 0010, 0011, 0100, 0101, 0110 & 0111' i.e. '0, 1, 2, 3, 4, 5, 6 & 7'

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The minimised expression for the given logic function as obtained from K-Map is

$$f(A,B,C,D) = A(\bar{B}+C)$$

DON'T - Care Conditions :-

For simplification of logic function using K-Map we make the entries in the map for either 1's or 0's. The cells which do not contain 1 are assumed to contain 0 and vice-versa. This is not always true since there are cases in which certain combination of input variables do not matter. In such

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cases the designer has a flexibility and it is left to him whether to assume a 0 or a 1 as output for each of these combinations. This condition is known as "don't-care" condition and can be represented on the K-map as a 'X' mark in the corresponding cell. The 'X' mark in the cell may be assumed to be a '1 or a 0' depending upon which one leads to a simpler expression. The function can be ~~spec~~ specified in one of the following ways:

1. In terms of minterms and don't-care condition. For example.

$f(A,B,C,D) = \Sigma m(5,6,10,13,15) + d(7,8,4)$

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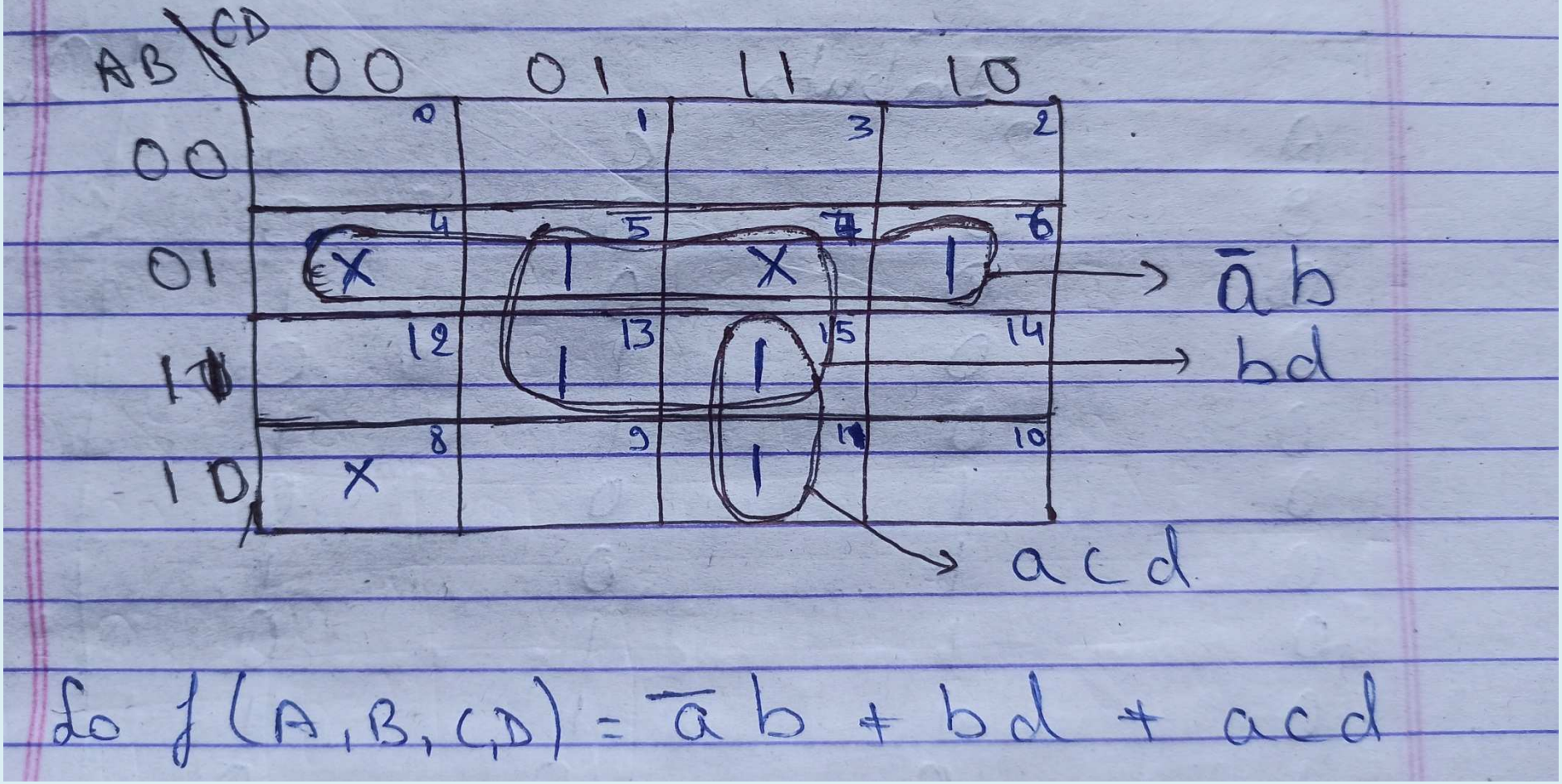
Its K-map and the minimised expression are given below,



So $f(A,B,C,D) = \bar{a}b + bd + acd$

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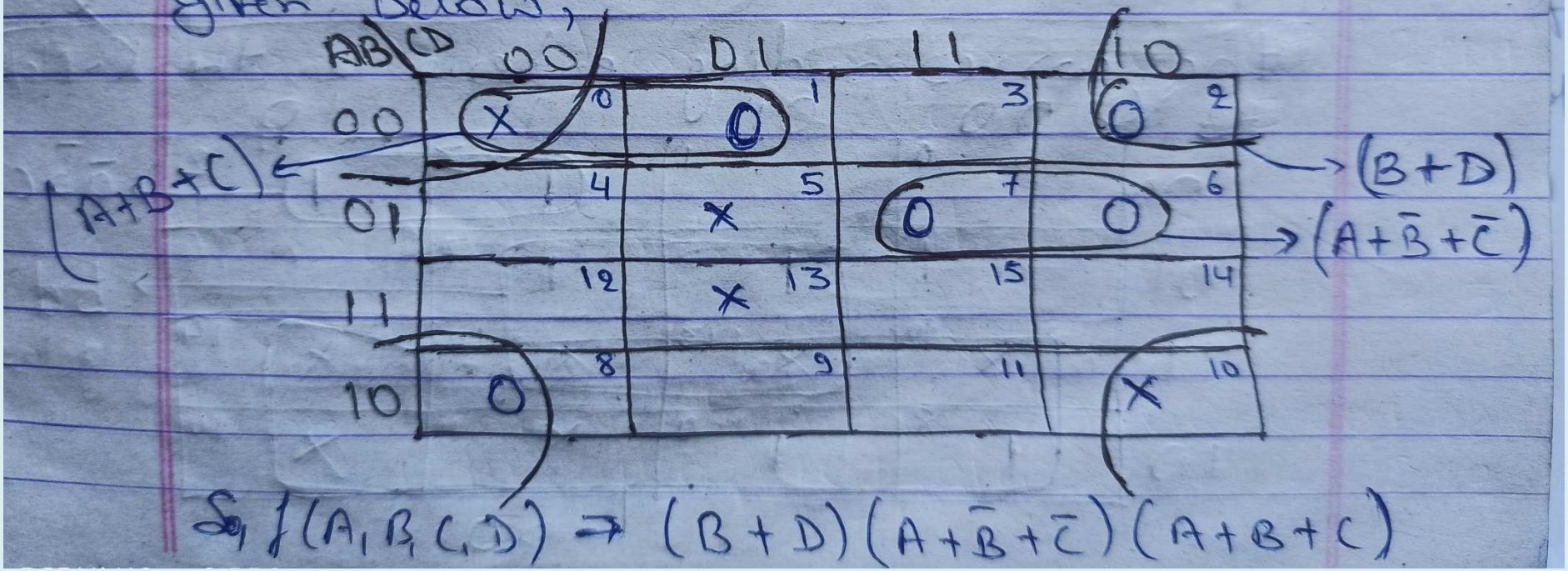
(2.) In terms of maxterms and don't care conditions. For example

$f(A, B, C, D) = \pi M(1, 2, 6, 7, 8) \cdot d(0, 5, 10, 13)$

Its K-map and the minimised expression are given below,



So, $f(A, B, C, D) \Rightarrow (B+D)(A+\bar{B}+\bar{C})(A+B+C)$

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Refer book- Modern Digital Electronics by RP Jain.

Thank You