Ex) Simplify the Boolean Function

$$F(A,B,C) = \Sigma(1,2,4,5)$$

and don't care condition $= (6,7)$

A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	X
1	1	1	X

A \ BC	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$		1		1
A	1	1	X	X

$$F = A + \bar{B}C + B\bar{C}$$

Ex) Simplify the Boolean Function

$$F(A,B,C) = \pi(0,1,3,4)$$

and don't care $(2,6)$

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	X
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	X

A \ BC	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	0	0	0	X
A	0			X

$$\overline{F} = \overline{\bar{A} + \bar{C}}$$

$$F = AC$$

Ex) Simplify the Boolean function

$$F(A,B,C,D) = ABC\bar{D} + \bar{A}BC\bar{D} + \bar{A}\bar{B}CD + \bar{A}\bar{B}\bar{C}D + AB\bar{C}\bar{D} + A\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}\bar{C}\bar{D}$$

Sol^:-

A	B	C	D	F
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	1
1	1	1	1	0

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1	1	1	1
$\bar{A}B$				
AB	1			1
$A\bar{B}$		1		

$$F = \bar{A}\bar{B} + \bar{A}\bar{C}D + AB\bar{D} + \bar{B}\bar{C}D$$

Ex) Simplify the function which represent an BCD code $F(A,B,C,D) = \Sigma(2,3,6,7,8,9)$

Sol^:-

A	B	C	D	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1

A	B	C	D	F
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$			1	1
$\bar{A}B$			1	1
AB	X	X	X	X
$A\bar{B}$	1	1	X	X

$F = A + C$

Ex) Design a logic cct using NAND gate only to convert BCD code to Ex-3 code?

Sol^n :-

i/p BCD				o/p Ex-3			
A	B	C	D	x	y	z	w
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0

don't Care (d) $= \sum 10, 11, 12, 13, 14, 15$

$X = \sum 5, 6, 7, 8, 9$

$y = \sum 1, 2, 3, 4, 9$

$W = \sum 0, 2, 4, 6, 8$

$Z = \sum 0, 3, 4, 7, 8$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$				
$\bar{A}B$		1	1	1
AB	X	X	X	X
$A\bar{B}$	1	1	X	X

$X = A + BD + BC$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$		1	1	1
$\bar{A}B$	1			
AB	X	X	X	X
$A\bar{B}$		1	X	X

$y = \bar{B}C + \bar{B}D + B\bar{C}\bar{D}$

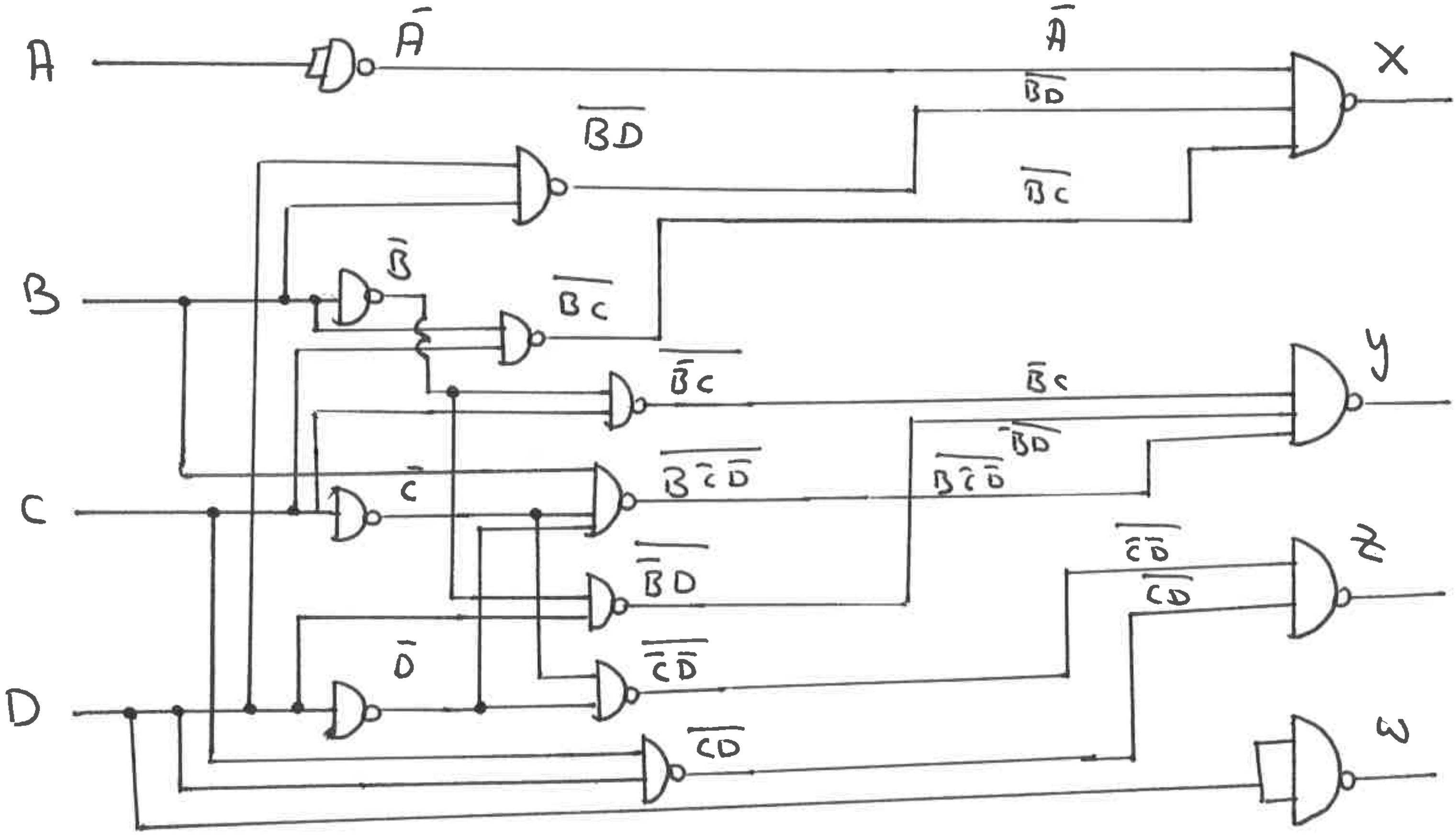
AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1			1
$\bar{A}B$	1			1
AB	X	X	X	X
$A\bar{B}$	1		X	X

$w = \bar{D}$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1		1	
$\bar{A}B$	1		1	
AB	X	X	X	X
$A\bar{B}$	1		X	X

$Z = \bar{C}\bar{D} + CD$

The Logic cct :-



$$X = \overline{\bar{A}\cdot\overline{BD}\cdot\overline{BC}} = A + BD + BC$$

$$y = \overline{\overline{\bar{B}C}\cdot\overline{\bar{B}D}\cdot\overline{B\bar{C}\bar{D}}} = \bar{B}C + \bar{B}D + B\bar{C}\bar{D}$$

$$Z = \overline{\overline{\bar{C}\bar{D}}\cdot\overline{CD}} = \bar{C}\bar{D} + CD$$

$$D = \bar{D}$$

Ex) Design a logic cct to convert Ex-3 code to BCD code?

Ex-3 (i/p)				BCD (o/p)			
A	B	C	D	X	y	Z	ω
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	1
0	1	0	1	0	0	1	0
0	1	1	0	0	0	1	1
0	1	1	1	0	1	0	0
1	0	0	0	0	1	0	1
1	0	0	1	0	1	1	0
1	0	1	0	0	1	1	1
1	0	1	1	1	0	0	0
1	1	0	0	1	0	0	1

$d = \Sigma\, 0, 1, 2, 13, 14, 15$

$X = \Sigma\, 11, 12$

$y = \Sigma\, 7, 8, 9, 10$

$W = \Sigma\, 1, 3, 4, 6, 8, 10$

$Z = \Sigma\, 5, 6, 9, 10$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	X	X		X
$\bar{A}B$				
AB	1	X	X	X
$A\bar{B}$			1	

$X = AB + ACD$

AB \ CD				
	X	X		X
			1	
		X	X	X
	1	1		1

$y = \bar{B}\bar{C} + BCD + AC\bar{D}$

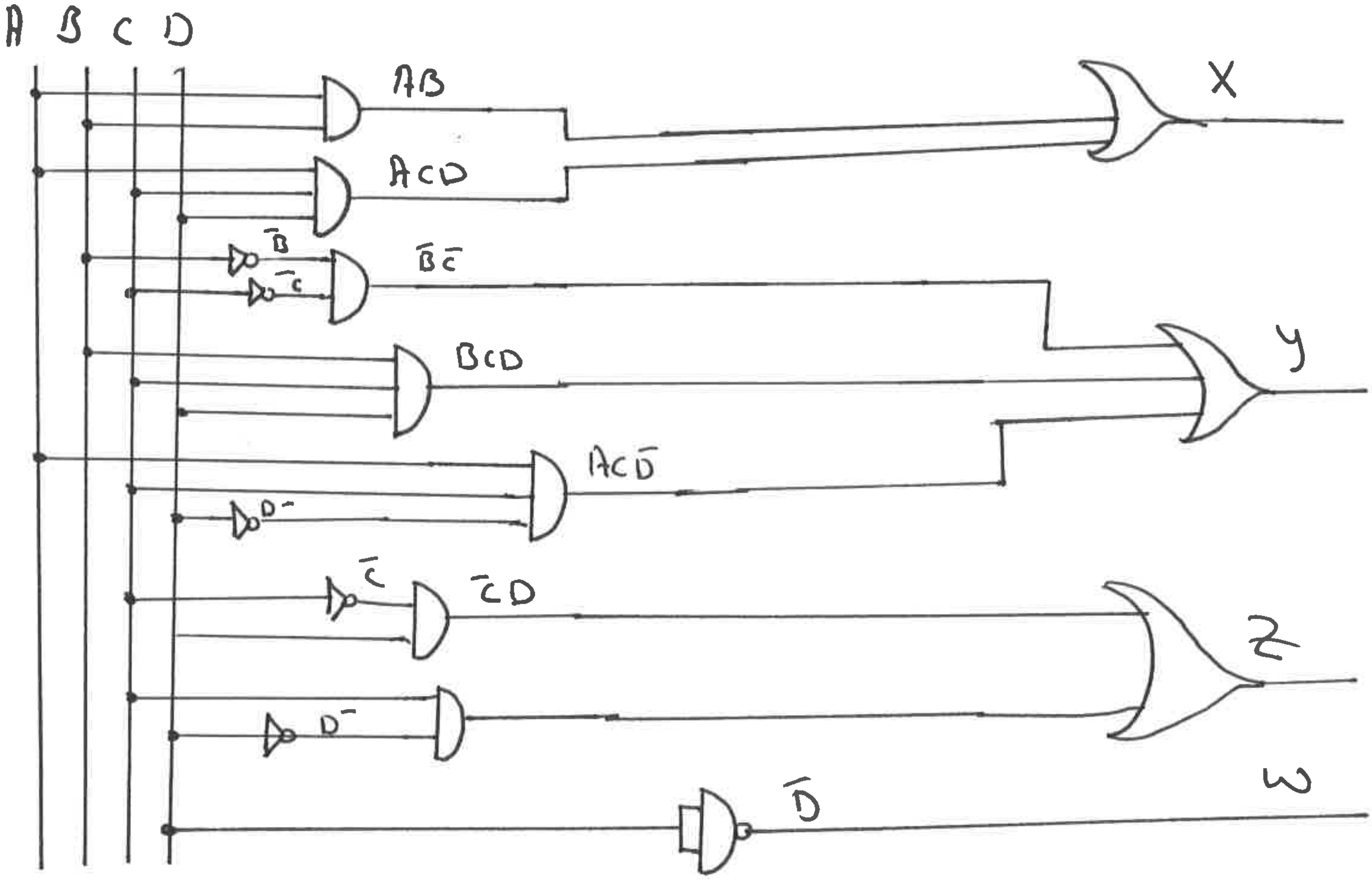
AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	X	X		X
$\bar{A}B$	1			1
AB	1	X	X	X
$A\bar{B}$	1			1

$W = \bar{D}$

AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	X	X		X
$\bar{A}B$		1		1
AB		X	X	X
$A\bar{B}$		1		1

$Z = \bar{C}D + C\bar{D}$

The Logic cct :-



$X = AB + ACD$

$Y = \bar{B}\bar{C} + BCD + AC\bar{D}$

$Z = \bar{C}D + C\bar{D} \cong C \oplus D$

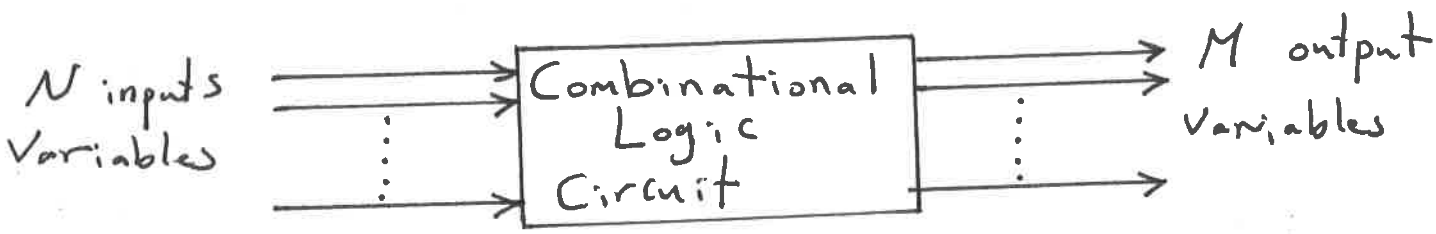
$W = \bar{D}$

Combinational Logic Circuits

A combinational circuits consist of input Variables, Logic and output Variables, the Logic gates accept Signals from the inputs and generate Signals to the output.

This process transform's binary Information from the given input data ~~to~~ required output data. obviously, both input and output data are represented by binary Signals, i.e(they exist in two possible values, one representing Logic (1) and the other Logic(0).

A block diagram of a combinational circuit is shown in fig. below. The N input binary Variable come from an external sources the M output Variables go to an external destination.



Block diagram of a Combinational Circuit

Combination Logic :-

Design Procedure

1. The problem is stated.
2. The number of ~~avariables~~ input variables and required output variables is determined.
3. The inputs and outputs variables are assigned letter symbols.
4. The truth table that driven the required relationship between inputs and outputs is derived.
5. The Simplified Boolean function for each output is obtain.
6. The Logic diagram.

Functions of Combinational Logic

1. ADDERS / Subtractor, Parallel Binary Adder
2. Comparators.
3. Decoders.
4. Encoders.
5. Multiplexer (Data Selector).
6. De Multiplexer.
7. Parity Generators / checker.

ADDERS

It is a combinational circuit that perform the addition of bits, there are two types of the adders :-

1. Half-Adder (H.A).
2. Full-Adder (F.A).

1. Half-Adder (H.A) :-

It is a combinational circuit that perform the addition of two binary bits.

Ex)

$$\begin{array}{r} 1101 \\ 0110 \\ \hline 10011 \end{array}$$

Truth table

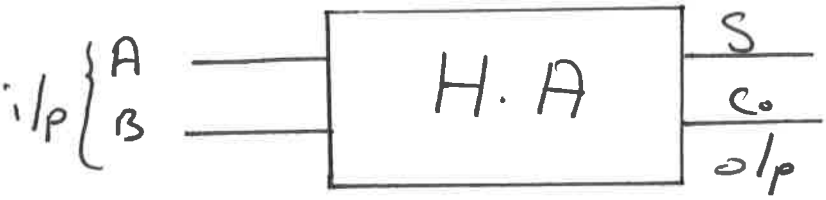
i/p A	i/p B	o/p S	o/p C_o
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

where :-

S : Sum

C_o : Carry

Block Diagram



From truth table:-

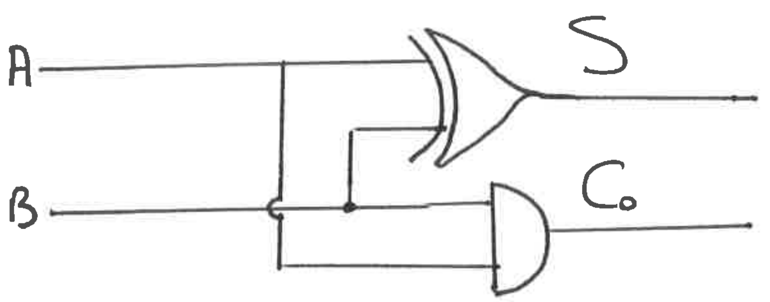
$$S = \Sigma\, 1,2$$

$$C = \Sigma\, 3$$

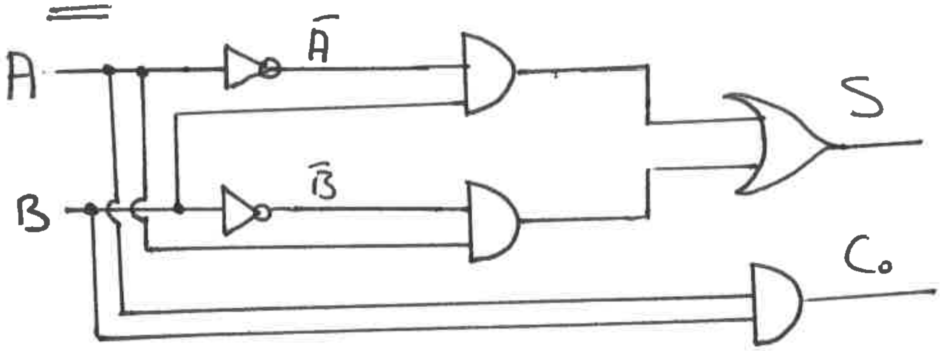
$$S = \bar{A}B + A\bar{B} = A \oplus B$$

$$C_o = AB = AB$$

Logic cct:-



or



or $S = \pi\, 0,3 = (A+B)(\bar{A}+\bar{B})$

$C_o = \pi\, 0,1,2 = (A+B)(A+\bar{B})(\bar{A}+B)$