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Subject: Digital & Logic Design

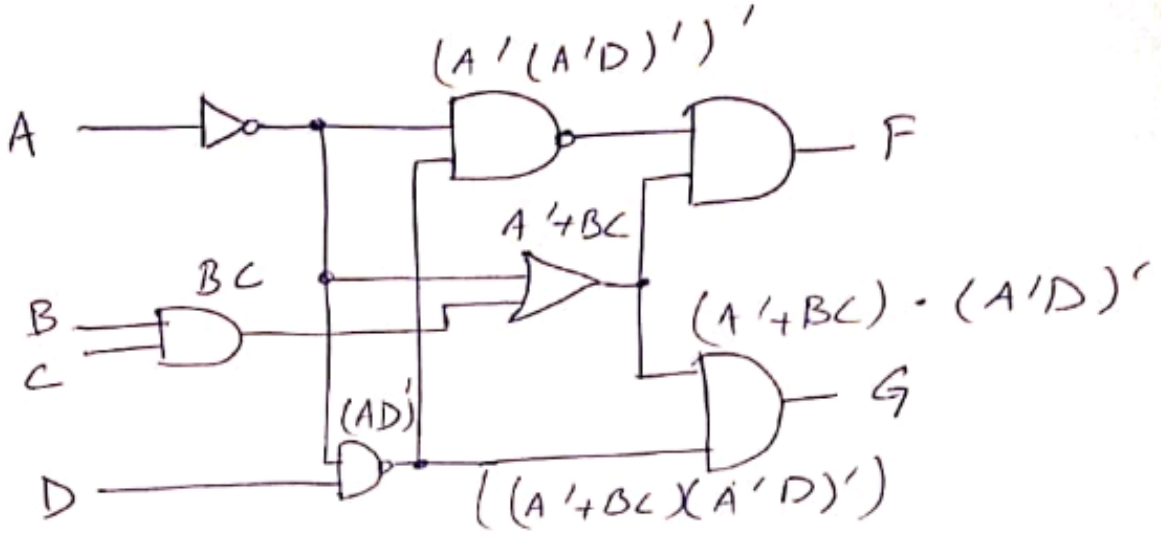
Assignment # 04

Submitted to Mam. Anna Arif

Date: 6-06-2022

(2)

(4.2)



$F = (A'(A'D)')(A+BC)$

$G = ((A'+BC)(A'D)')'$

(4.4)

a)

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

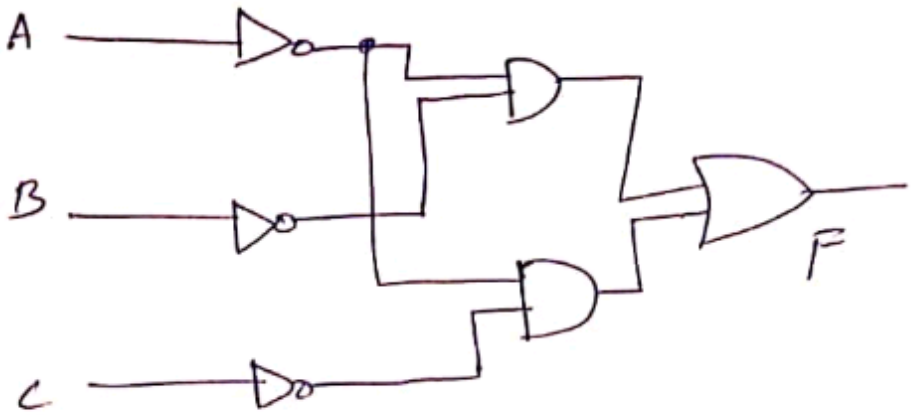
K-map:

A \ BC	00	01	11	10
0	1	1	0	1
1	0	0	0	0

$F = A'B' + A'C'$

(5)

Combinational Circuit



(b)

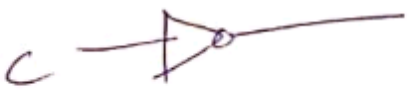
A	B	C	F
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
0	1	0	1
1	0	1	0
1	0	0	1
1	1	0	0
1	1	1	

K-map

A \ BC	00	01	11	10
0	1	0	0	1
1	1	0	0	1

$F = C'$

Logic Diagram:



(4)

(4.6)

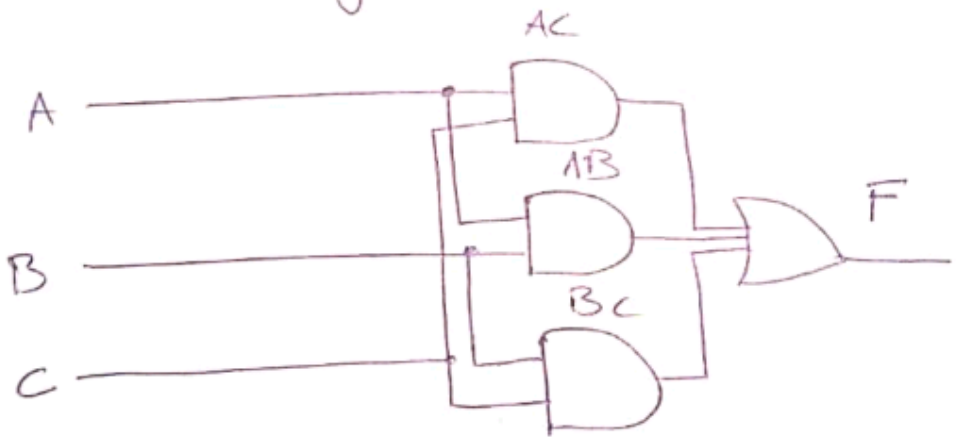
A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	ϕ
1	1	0	1
1	1	1	1

K-map

A \ BC	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$F = AC + AB + BC$

Logic Diagram:

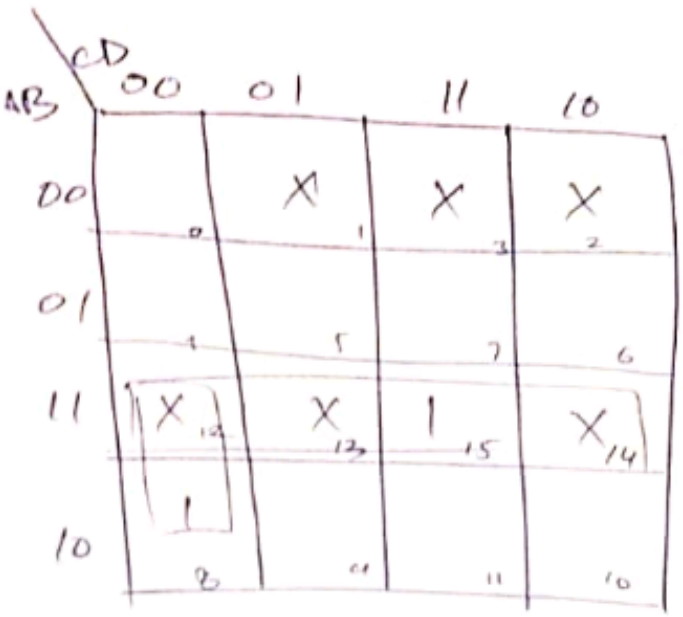


(4.8)

a) 8, 4, −2, −1 to BCD

A	B	C	D	w	x	y	z
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	0	0	0	1	0
0	0	1	1	0	0	1	1
0	1	0	0	0	1	0	0
0	1	0	1	0	1	0	1
0	1	1	0	0	1	1	0
0	1	1	1	0	1	1	1
1	0	0	0	1	0	0	0
1	0	0	1	1	0	0	1
1	0	1	0	1	0	1	0
1	0	1	1	1	0	1	1
1	1	0	0	1	1	0	0
1	1	0	1	1	1	0	1
1	1	1	0	1	1	1	0
1	1	1	1	1	1	1	1

w:

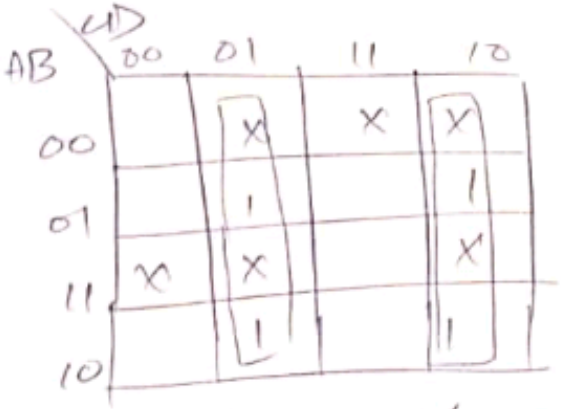


$w = AB + AC'D'$

x:

$x = B'C + B'D + BCD'$

y:

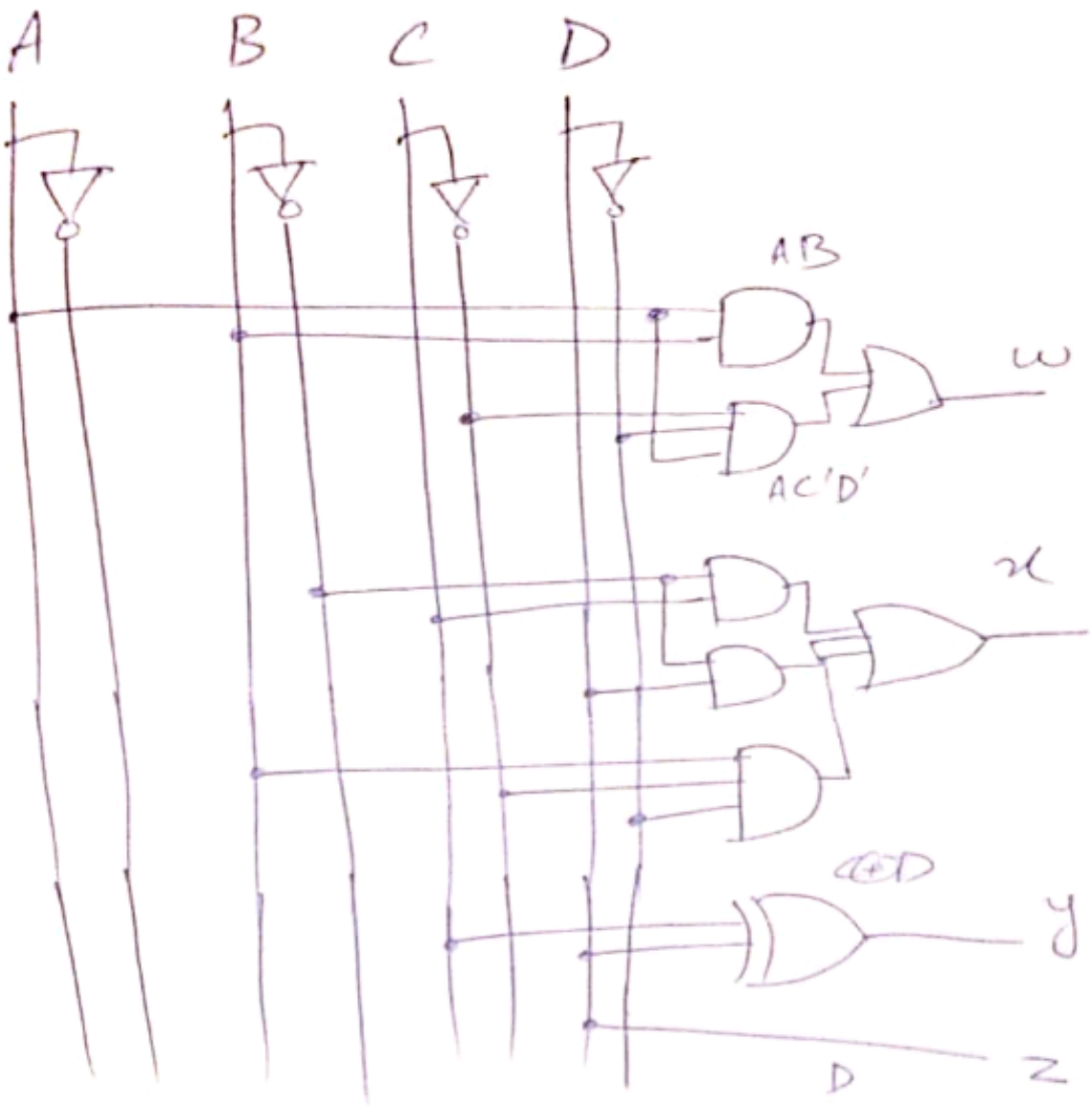


$y = CD' + C'D$

$C \oplus D$

$z = D$

Combinational Circuit:



(4.10) ①

A	B	C	D	w	x	y	z
0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	1
0	0	1	0	1	1	1	0
0	0	1	1	1	1	0	1
0	1	0	0	1	1	0	0
0	1	0	1	1	0	1	1
0	1	1	0	1	0	0	1
0	1	1	1	1	0	0	0
1	0	0	0	1	0	0	0
1	0	0	1	0	1	1	1
1	0	1	0	0	1	1	0
1	0	1	1	0	1	0	1
1	1	0	0	0	1	0	0
1	1	0	1	0	0	1	1
1	1	1	0	0	0	1	0
1	1	1	1	0	0	0	1

w:

AB \ CD	00	01	11	10
00	0	1	1	1
01	1	1	1	1
11	0	0	0	0
10	1	0	0	0

$w = A'(B+C+D)$

$= AB'C'D'$

$\Rightarrow A \oplus (B+C+D)$

x:

AB \ CD	00	01	11	10
00	0	1	1	1
01	1	0	0	0
11	1	0	0	0
10	0	1	1	1

$$x = B'(C+D) + CB'D'$$

$$x = B \oplus (C+D)$$

y:

AB \ CD	00	01	11	10
00	0	1	0	1
01	0	1	0	1
11	0	1	0	1
10	0	1	0	1

$$y = CD' + C'D$$

$$y = C \oplus D$$

z:

AB \ CD	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	0	1	1	0
10	0	1	1	0

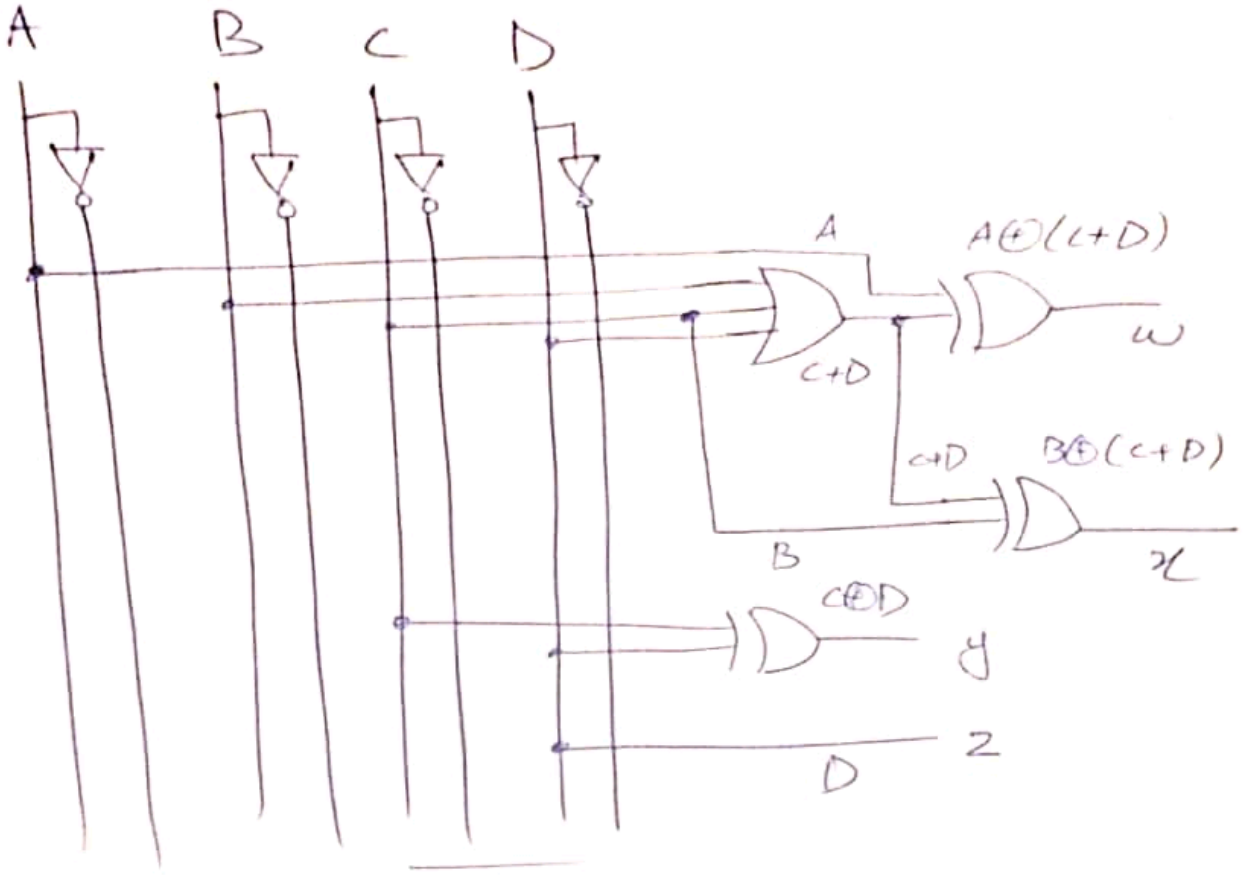
$$z = D$$

For a 5's complement with input E & output V

$$V = E \oplus (A+B+C+D)$$

Combinational Circuit

(5) (4)



(4.12)

a) Half Subtractor:

A	B	D	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

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$D = x'y + xy' = x \oplus y$

or $A \oplus B$

$B_{borrow} = A'B$

b) Full Subtractor:

A	B	Cin	Borrow	Diff
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	1	0
0	0	0	0	1
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

$Diff = x \oplus y \oplus z$

$Borrow = x'y + x'z + yz$

(4.16)

a)

$$(C'G_i' + P_i')' = (C_i + G_i)P_i + G_iP_i + P_iC_i$$

$$= A_iB_i(A_i + B_i) + P_iG_i$$

$$= A_iB_i + P_iC_i = G_i + P_iC_i$$

$$(P_iG_i') \oplus C_i = (A_i + B_i)(A_iB_i)' \oplus C_i$$

$$= (A_i + B_i)(A_i' + B_i') \oplus C_i$$

$$= (A_i'B_i + A_iB_i') \oplus C_i = A_i \oplus B \oplus C_i$$

$$= S_i$$

b)

Output of NOR gate $= (A_0 + B_0)' = P_0'$

Output of NAND gate $= (A_0B_0)' = G_0'$

$$S_1 = (P_0G_0') \oplus C_0$$

$$C_1 = (C_0'G_0' + P_0')'$$

— (4.14) —

Propagation times of

XOR = 10ns

OR = 5 ns

AND = 5 ns

Time = 10 + 5 + 5 ⇒ 20ns

4.18

a) BCD → 9's complement

A	B	C	D	output ABCD (wxyz)	Gray code
0	0	0	0	1001	0000
0	0	0	1	1000	0001
0	0	1	0	0111	0011
0	0	1	1	0110	0010
0	1	0	0	0101	0110
0	1	0	1	0100	0111
0	1	1	0	0011	0101
0	1	1	1	0010	0100
1	0	0	0	0001	1100
1	0	0	1	0000	1101

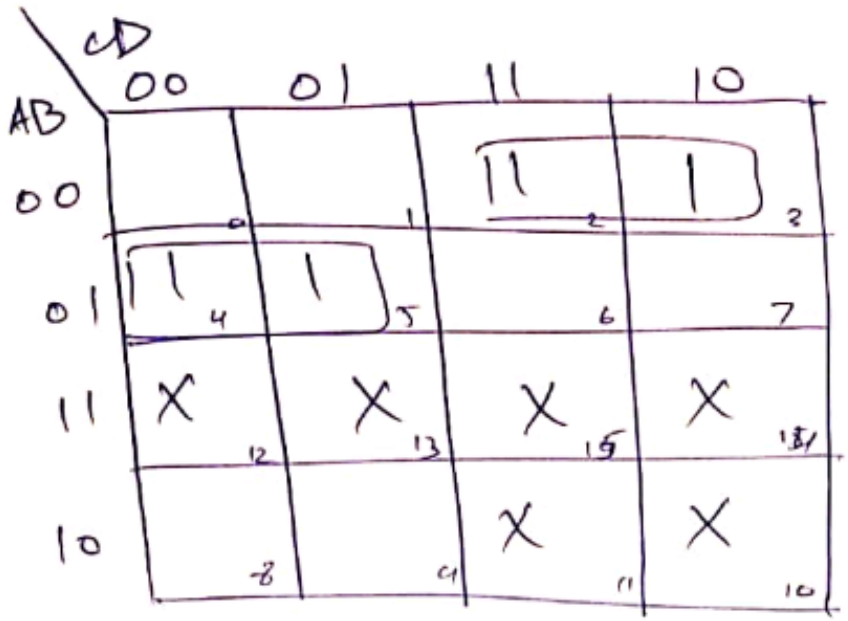
$= \Sigma(10, 11, 12, 13, 14, 15)$

w :

AB \ CD	00	01	11	10
00	1 (0)	1 (1)	(3)	(2)
01	(4)	(5)	(7)	(6)
11	X (12)	X (13)	X (15)	X (14)
10	(8)	(9)	X (11)	X (10)

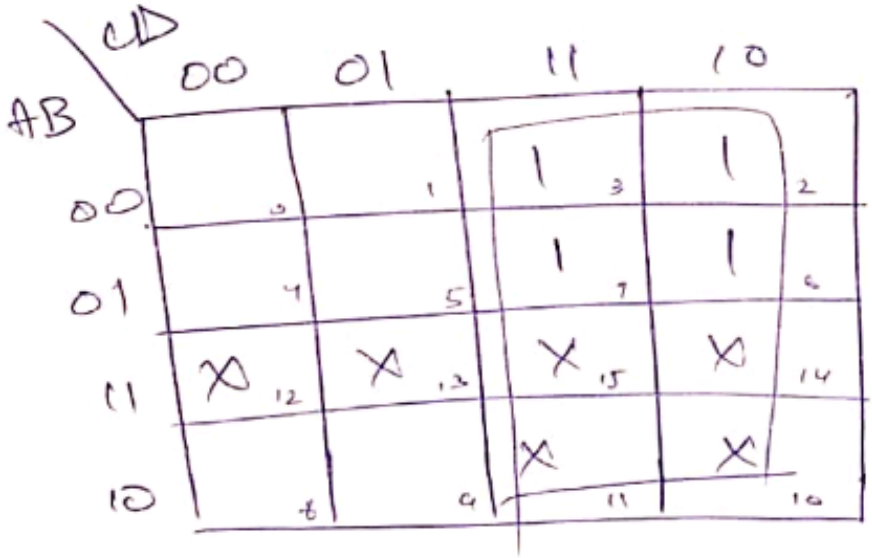
$w = A'B'C'$

x:



$x = BC' + B'C = B \oplus C$

y:



$y = C$

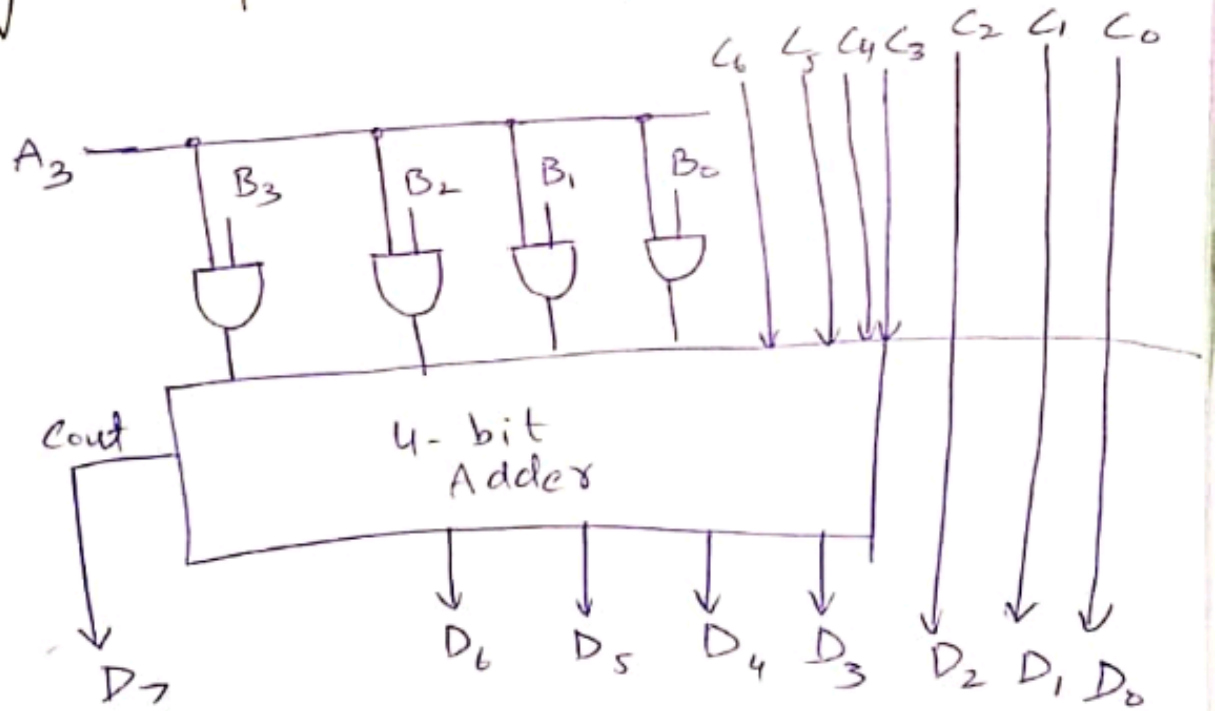
z:

AB \ CD	00	01	11	10
00	1			1
01	1	1		1
11	X	X	X	X
10	1		X	X

$z = D'$

(4.20)

Binary multiplier: (2 unsigned numbers)



(4.22)

Excess-3 → binary decoder

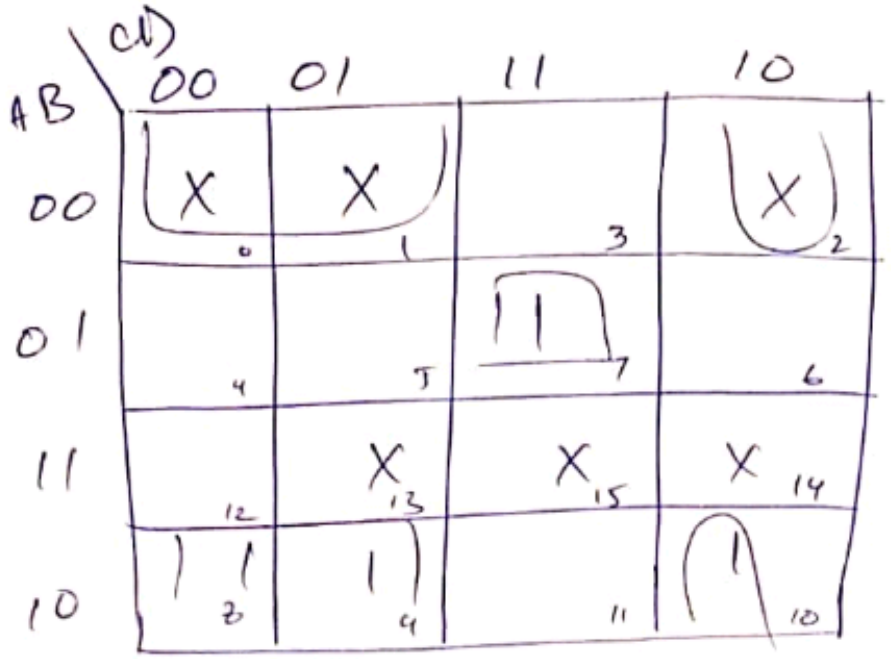
A	B	C	D	w	x	y	z
0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	1
0	1	0	1	0	0	1	0
0	1	1	0	0	0	1	1
0	1	1	1	0	1	0	0
1	0	0	0	0	1	0	1
1	0	0	1	0	1	1	0
1	0	1	0	0	1	1	1
1	0	1	1	1	0	0	0
1	1	0	0	1	0	0	1

w:

AB \ CD	00	01	11	10
00	X	X	0	0
01	0	0	0	0
11	1	X	X	X
10	0	0	1	0

$w = AB + ACD$

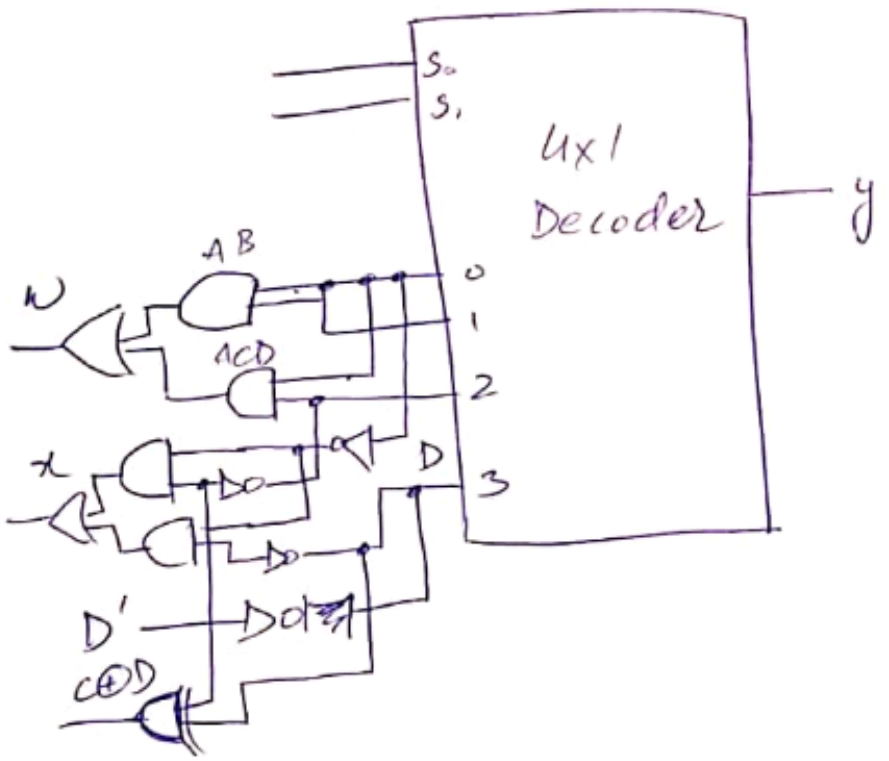
x:



$$x = B'C' + B'D' + BCD$$

$$y = C'D + CD' = C \oplus D$$

$$z = D'$$



(4.24)

Inputs A, B, C, D

$D_0 = A'B'C'D'$

$D_1 = A'B'C'D$

$D_2 = B'CD'$

$D_3 = B'CD$

$D_4 = BC'D'$

Outputs $D_0 \cdots D_9$

$D_5 = BC'D$

$D_6 = BCD'$

$D_7 = BCD$

$D_8 = AD'$

$D_9 = AD$

C

AB \ CD	00	01	11	10
00	D_0	D_1	D_3	D_2
01	D_4	D_5	D_7	D_6
11	X	X	X	X
10	D_8	D_9	X	X

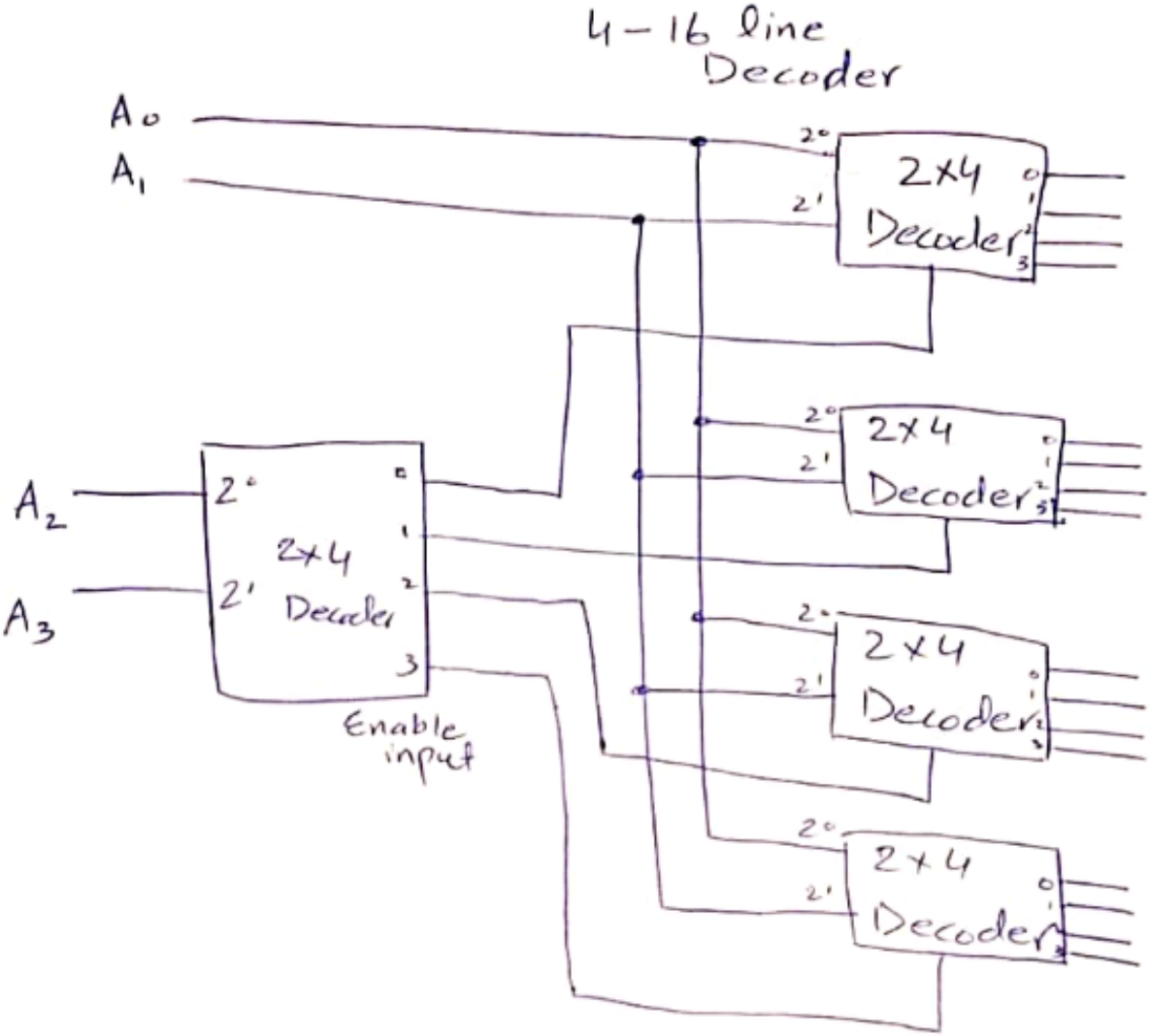
A

D

(4.26)

(13)

Construct 4-16 lines decoder with five 2-4 line decoders.



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(4.28)

a) $F_1 = x'y' + xz$, $F_2 = xy'z' + yz$

$F_3 = x'y'z' + xy$

$F_1 = x'y'(z+z') + xz(y+y')$

$= x'y'z + x'y'z' + xyz + xy'z$

$F_1 = \Sigma(0,1,2,7)$

BSE-133

$F_2 = x'y'z' + (x+x')yz$

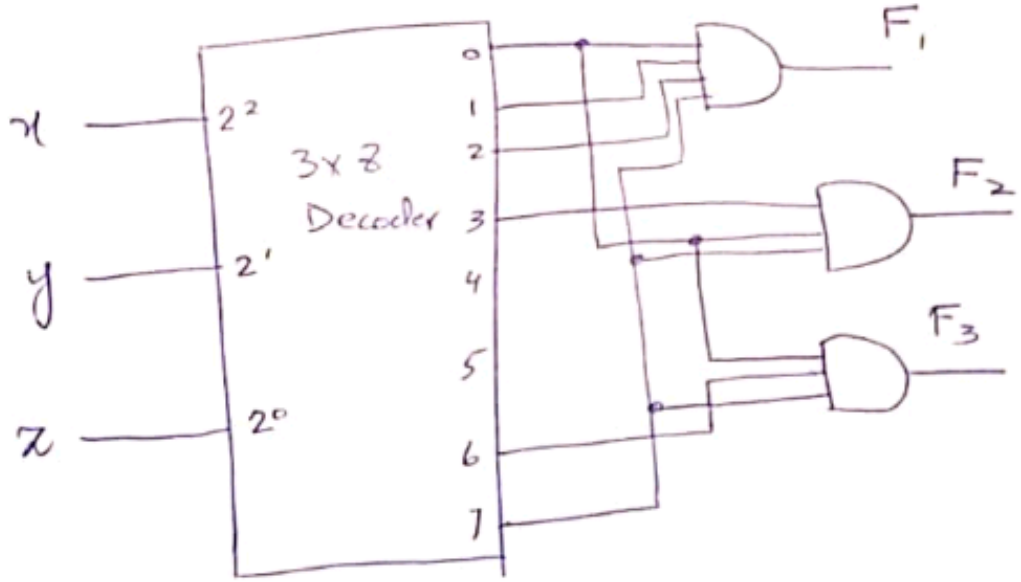
$= x'y'z' + xyz + x'yz$

$F_2 = \Sigma(0,3,7)$

$F_3 = x'y'z' + xy(z+z') \Rightarrow x'y'z' + xyz + xyz'$

$F_3 = \Sigma(0,6,7)$

3x8 Decoder required.



(4.30)

D_0	D_1	D_2	D_3	D_4	D_5	D_6	x	y	z	V
0	0	0	0	0	0	0	X	X	X	0
1	0	0	0	0	0	0	0	0	0	1
X	1	0	0	0	0	0	0	0	1	1
X	X	1	0	0	0	0	0	1	0	1
X	X	X	1	0	0	0	0	1	1	1
X	X	X	X	1	0	0	1	0	0	1
X	X	X	X	X	1	0	1	0	1	1
X	X	X	X	X	X	1	1	1	1	1

If $D_2 = 1$ & $D_6 = 1$, also $V = 1$

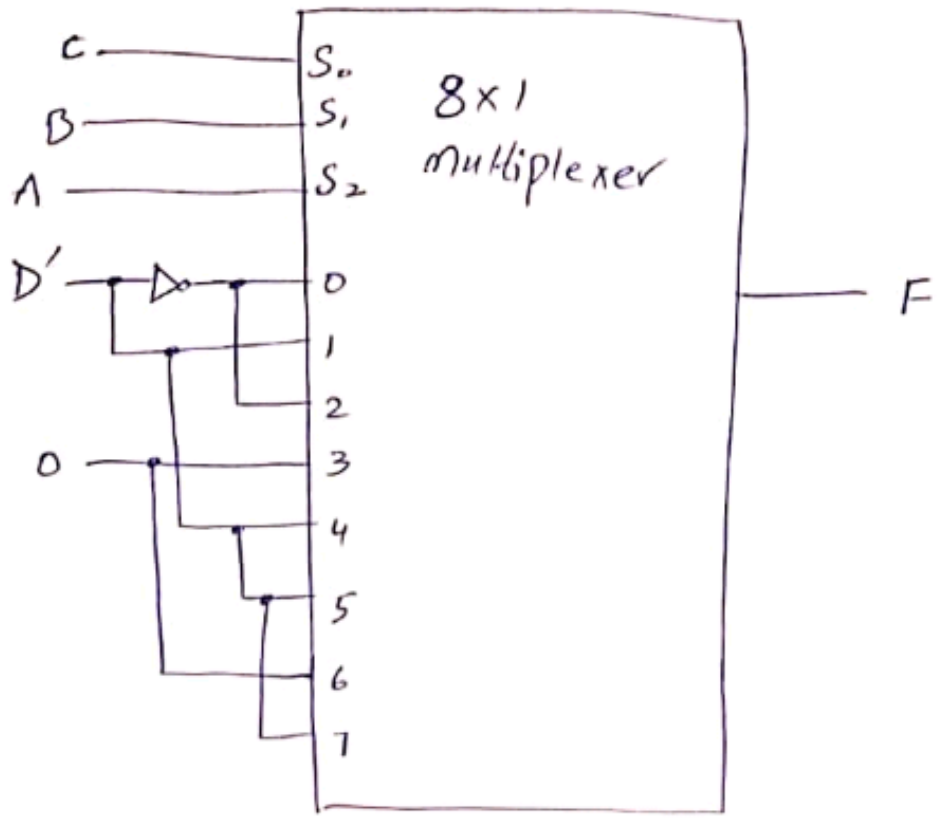
Output → xyz = 100

(4.32)

Implement with multiplexer: 16x1 multiplexer

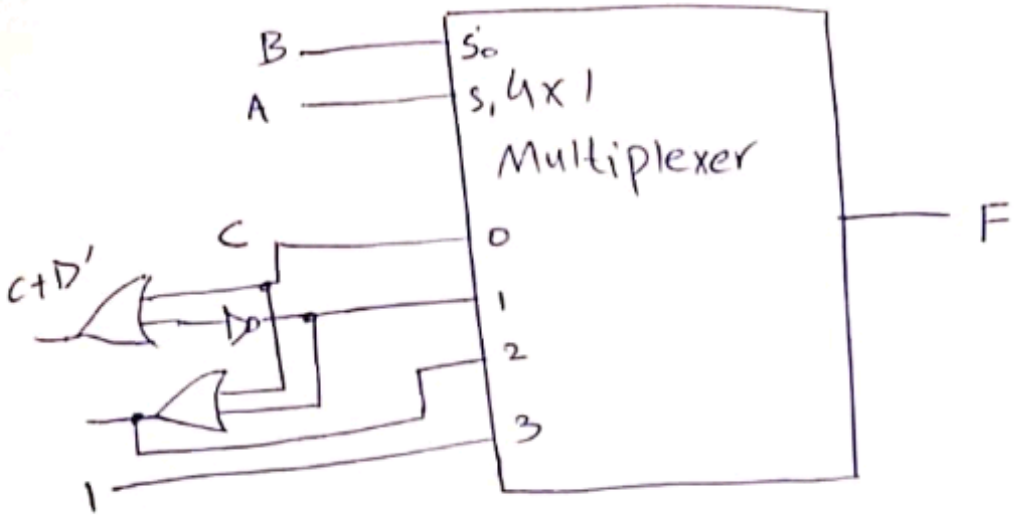
a) $F(A, B, C, D) = \Sigma(0, 2, 5, 8, 10, 14)$

A	B	C	D	F	
0	0	0	0	1	$F = D'$
0	0	0	1	0	
0	0	1	0	1	$F = D'$
0	0	1	1	0	
0	1	0	0	0	$F = D$
0	1	0	1	1	
0	1	1	0	0	$F = 0$
0	1	1	1	0	
1	0	0	0	1	$F = D'$
1	0	0	1	0	
1	0	1	0	1	$F = D'$
1	0	1	1	0	
1	1	0	0	0	$F = 0$
1	1	0	1	1	
1	1	1	0	0	$F = D'$
1	1	1	1	1	



b) $F(A, B, C, D) = \Pi(2, 6, 11)$

A	B	C	D		F	
0	0	0	0	0	1	
0	0	0	1	1	1	$F = C + D'$
0	0	1	0	2	0	
0	0	1	1	3	1	
0	1	0	0	4	1	
0	1	0	1	5	1	$F = C + D'$
0	1	1	0	6	0	
0	1	1	1	7	1	
1	0	0	0	8	1	
1	0	0	1	9	1	$F = C + D$
1	0	1	0	10	1	
1	0	1	1	11	0	
1	1	0	0	12	1	
1	1	0	1	13	1	$F = 1$
1	1	1	0	14	1	
1	1	1	1	15	1	



(4.34)

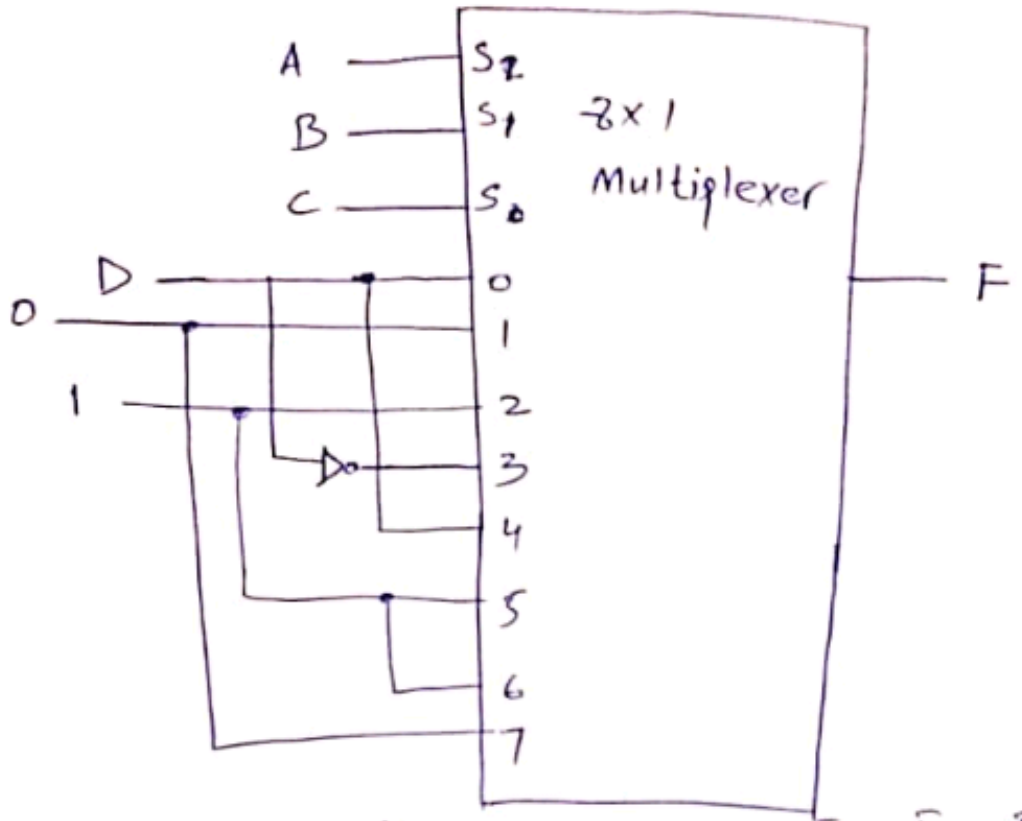
a) $I_1 = I_7 = 0$, $I_2 = I_5 = I_6 = 1$,

$I_0 = I_4 = D$, $I_3 = D'$

A	B	C	D	I	F	
0	0	0	0	$I_0 = D$	0	0
0	0	0	1		1	1
0	0	1	0	$I_1 = 0$	0	2
0	0	1	1		0	3
0	1	0	0	$I_2 = 1$	1	4
0	1	0	1		1	5
0	1	1	0	$I_3 = D'$	1	6
0	1	1	1		0	7
1	0	0	0	$I_4 = D$	0	8
1	0	0	1		1	9
1	0	1	0	$I_5 = 1$	1	10
1	0	1	1		1	11
1	1	0	0	$I_6 = 1$	1	12
1	1	0	1		1	13
1	1	1	0	$I_7 = 0$	0	14
1	1	1	1		0	15

$F = \Sigma(1, 4, 5, 6, 9, 10, 11, 12, 13)$

Block Diagram



(b)

$I_2 = I_3 = I_6 = 0$

$I_5 = 1, I_0 = I_1 = D$

$I_4 = I_7 = D'$

A	B	C	D	I	F	
0	0	0	0	$I_0 = D$	0	0
0	0	0	1		1	1
0	0	1	0	$I_1 = D$	0	2
0	0	1	1		1	3
0	1	0	0	$I_2 = 0$	0	4
0	1	0	1		0	5
0	1	1	0	$I_3 = 0$	0	6
0	1	1	1		0	7
1	0	0	0	$I_4 = D'$	1	8
1	0	0	1		0	9
1	0	1	0	$I_5 = 1$	1	10
1	0	1	1		1	11
1	1	0	0	$I_6 = 0$	0	12
1	1	0	1		0	13
1	1	1	0	$I_7 = D'$	1	14
1	1	1	1		0	15

$F \Rightarrow \Sigma(1, 3, 8, 10, 11, 19)$

Block Diagram (b)