Questions

$\boxed{2.10}$ Given The Boolean Functions F_1 & F_2 Show that.

(a) The Boolean Function $E = F_1 + F_2$ Contains The Sum of The minterms of F_1 & F_2

$$F_1 = \sum m_{1i} = (m_{1.1} + m_{1.2} - - - -)$$

$$F_2 = \sum m_{2i} = (m_{2.1} + m_{2.2} + - - -)$$

$$F_1 + F_2 = \sum m_{1i} + \sum m_{2i}$$

$$= \sum (m_{1i} + m_{2i}) \ \#$$

(b) The Boolean Function $G = F_1 F_2$ Contains only The minterms That are Common to F_1 & F_2.

$$F_1 F_2 = \sum m_i \sum m_j$$

Where $m_i m_j = 0$ if $i \neq j$

$m_i m_j = 1$ if $i = j$.

$\boxed{2.16}$ The logical sum of All minterms of a Boolean Functions of n Variables is 1

a) prove The previous Statement of $n=3$

Variables $n=3$

For Ex: A,B,C

A	B	C	F	
0	0	0	$A'B'C'$	m_0
0	0	1	$A'B'C$	m_1
0	1	0	ABC'	m_2
0	1	1	$A'BC$	m_3
1	0	0	$AB'C'$	m_4
1	0	1	$AB'C$	m_5
1	1	0	ABC'	m_6
1	1	1	ABC	m_7

$$F = A'B'C' + A'B'C + A'BC' + A'BC + AB'C' + AB'C + ABC' + ABC$$

$$= A'(B'C' + B'C + BC' + BC) + A(B'C' + BC' + B'C + BC)$$

$$= (B'C' + BC' + B'C + BC)(A + A')$$

$$= B'C' + BC' + B'C + BC.$$

$= B'(C'+C) + B(C'+C)$

$= B' + B = \boxed{1}$ #

$\boxed{2.17}$ obtain The Truth Table of The Following Functions & Express each Function in Sum of Minterms & product of Maxterms Form:

$\boxed{a}$ $(xy+z)(y+xz)$

x	y	z	xy	xy+z	xz	y+xz	(xy+z)(y+xz)
0	0	0	0	0	0	0	$0 \rightarrow m_0$
0	0	1	0	1	0	0	$0 \rightarrow m_1$
0	1	0	0	0	0	1	$0 \rightarrow m_2$
0	1	1	0	1	0	1	$1 \rightarrow m_3$
1	0	0	0	0	0	0	$0 \rightarrow m_4$
1	0	1	0	1	1	1	$1 \rightarrow m_5$
1	1	0	1	1	0	1	$1 \rightarrow m_6$
1	1	1	1	1	1	1	$1 \rightarrow m_7$

* Sum of Minterms:

$$F(x,y,z) = \sum(3,5,6,7)$$

* product of Maxterms:

$$F(x,y,z) = \prod(0,1,2,4)$$

[b] $(x+y')(y'+z)$

x	y	z	y'	$x+y'$	$y'+z$	$(x+y')(y'+z)$	
0	0	0	1	1	1	1	m_0
0	0	1	1	1	1	1	m_1
0	1	0	0	0	0	0	m_2
0	1	1	0	0	1	0	m_3
1	0	0	1	1	1	1	m_4
1	0	1	1	1	1	1	m_5
1	1	0	0	1	0	0	m_6
1	1	1	0	1	1	1	m_7

* Sum of Minterms:

$$F(x,y,z) = \sum(0,1,4,5,7)$$

* product of Maxterms

$$F(x,y,z) = \prod(2,3,6)$$

[c] $x'y + wx'y + wyz' + w'y'$

w	x	y	z	$x'z$	$wx'y$	wyz'	$w'y'$	F	
0	0	0	0	0	0	0	1	1	m_0
0	0	0	1	1	0	0	1	1	m_1
0	0	1	0	0	0	0	0	0	m_2
0	0	1	1	1	0	0	0	1	m_3
0	1	0	0	0	0	0	1	1	m_4
0	1	0	1	0	0	0	1	1	m_5
0	1	1	0	0	0	0	0	0	m_6
0	1	1	1	0	0	0	0	0	m_7
1	0	0	0	0	0	0	0	0	m_8
1	0	0	1	1	0	0	0	1	m_9
1	0	1	0	0	1	1	0	1	m_{10}
1	0	1	1	1	1	0	0	1	m_{11}
1	1	0	0	0	0	0	0	0	m_{12}
1	1	0	1	0	0	0	0	0	m_{13}
1	1	1	0	0	0	1	0	1	m_{14}
1	1	1	1	0	0	0	0	0	m_{15}

* Sum of Minterms:

$$F(w,x,y,z) = \sum(0,1,3,4,5,9,10,11,14)$$

* product of Maxterms.

$$F(w,x,y,z) = \prod(2,6,7,8,12,13)$$

$\boxed{d}$ $(xy + yz' + x'z)(x+z)$

x	y	z	xy	yz'	x'z	(xy+yz'+x'z)	(x+z)	F	
0	0	0	0	0	0	0	0	0	m_0
0	0	1	0	0	1	1	1	1	m_1
0	1	0	0	1	0	1	0	0	m_2
0	1	1	0	0	1	1	1	1	m_3
1	0	0	0	0	0	0	1	0	m_4
1	0	1	0	0	0	0	1	0	m_5
1	1	0	1	1	0	1	1	1	m_6
1	1	1	1	0	0	1	1	1	m_7

* Sum of Minterms :

$F(x, y, z) = \sum(1, 3, 6, 7)$

* product of Maxterms:

$F(x, y, z) = \prod(0, 2, 4, 5)$

$\boxed{2.19}$ Express The Following Function as a Sum of Minterms & as a product of Maxterms

$F(A,B,C,D) = B'D + A'D + BD$

A	B	C	D	B'D	A'D	BD	F = (A'D+B'D+BD)	
0	0	0	0	0	0	0	0	m_0
0	0	0	1	1	1	0	1	m_1
0	0	1	0	0	0	0	0	m_2
0	0	1	1	1	1	0	1	m_3
0	1	0	0	0	0	0	0	m_4
0	1	0	1	0	1	1	1	m_5
0	1	1	0	0	0	0	0	m_6
0	1	1	1	0	1	1	1	m_7
1	0	0	0	0	0	0	0	m_8
1	0	0	1	1	0	0	1	m_9
1	0	1	0	0	0	0	0	m_{10}
1	0	1	1	1	0	0	1	m_{11}
1	1	0	0	0	0	0	0	m_{12}
1	1	0	1	0	0	1	1	m_{13}
1	1	1	0	0	0	0	0	m_{14}
1	1	1	1	0	0	1	1	m_{15}

* Sum of Minterms :

$F(A, B, C, D) = \sum(1, 3, 5, 7, 9, 11, 13, 15)$

* product of Maxterms:

$F(A, B, C, D) = \prod(0, 2, 4, 6, 8, 10, 12, 14)$

2.20 Express the Complement of the Following Functions in Sum of Minterms Form.

a) $F(A,B,C,D) = \sum(3,5,9,11,15)$.

* $F'(A,B,C,D) = \prod(0,1,2,4,6,7,8,10,12,13,14)$

b) $F(x,y,z) = \prod(2,4,5,7)$

* $F'(x,y,z) = \sum(0,1,3,6)$.

2.21 Convert each of The Following to other Canonical Form:

a) $F(x,y,z) = \sum(2,5,6)$

$F(x,y,z) = \prod(0,1,3,4,7)$

b) $F(A,B,C,D) = \prod(0,1,2,4,7,9,12)$

$F(A,B,C,D) = \sum(3,5,6,8,10,11,13,14,15)$

2.22 Convert each of the Following Expressions into Sum of products

a) $(AB+C)(B+C'D)$

$= ABB + ABC'D + BC + \cancel{CC'D}$

$= AB(B+C'D) + BC$

$= AB(1+C'D) + BC$

$= AB + BC$ //

b) $x' + x(x+y')(y+z') \longrightarrow \underline{x+yz}$ قانون

$= (\cancel{x'+x})\left[(x' + (x+y')) \cdot (y+z')\right]$

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

$(\cancel{1+y'})(x'+y+z')$

$= (x'+y+z')$ //

2.24 Show that The dual of The exclusive - OR is Equal to its Complement.

X	y	$F = X \oplus y$
0	0	0
0	1	1
1	0	1
1	1	0

X	Y	$F' = (X \oplus y)'$
0	0	1
0	1	0
1	0	0
1	1	1

$F = x'y + xy'$

$F' = (x'y + xy')' = (x + y')\cdot(x' + y)$

2.25 By substituting The Boolean Expression Equivalent of Binary operations as Defined in Table 2.8

a) The inhibition operation is neither Commutative Nor Associative.

* inhibitation operator $| \rightarrow x|y$
معناها لما X وعامل Not لل Y

$(x|y) = xy' \neq (y|x) = yx'$

$(x|y)|z = xy'z' \neq x(y|z) = x(yz')'$
$= x(y' + z)$
$= xy' + xz$

Xor

b) The Exclusive-OR operation is Commutative & Associative.

* $(X \oplus y) = xy' + x'y$ $\equiv$ Commutative
$(y \oplus x) = y'x + yx'$

* $(x \oplus y) \oplus z = x \oplus (y \oplus z)$ Associative

$x = 0$, $y = 1$, $z = 1$

$(0 \oplus 1) \oplus 1 = 0 \oplus (1 \oplus 1)$
$1 \oplus 1 \quad 0 \oplus 0$
$0 = 0$

2.26 Show that positive logic NAND Gate is a negative logic Nor Gate & Vice Versa

(positive) NAND

X	X	$F = (x \cdot y)'$
0	0	1
0	1	1
1	0	1
1	1	0

Nor (negative).

X	Y	$F = (x + y)'$
0	0	1
0	1	0
1	0	0
1	1	0

postive Gate

x	y	F=(x·y)'
L (0)	L(0)	H (1)
L(0)	H(1)	H (1)
H (1)	L(0)	H (1)
H (1)	H(1)	L (0)

Negative Gate

x	y	F= (x+y)'
L(0)	L (0)	H (1)
L(0)	H (1)	L (0)
H(1)	L(0)	L (0)
H(1)	H(1)	L (0)

1)

NAND postive.

x	y	F=(x·y)'
0	0	1
0	1	1
1	0	1
1	1	0

Nor Negative.

x	x	Z=(X+y)'
0	0	1
0	1	0
1	0	0
1	1	0

NAND negtive.

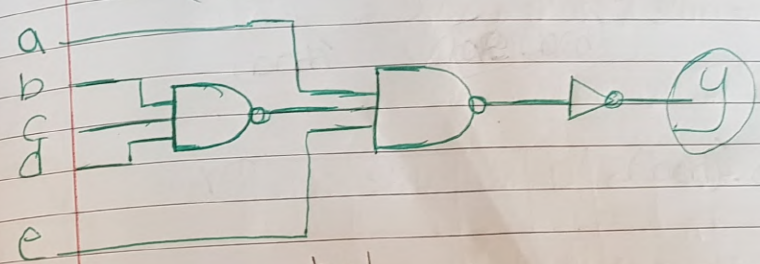
x	X	F=(x·y)'
0	0.	1
0	1	1
1	0	1
1	1	0

NOR positive.

x	y	F=(X+y)'
0	0	1
0	1	0
1	0	0
1	1	0

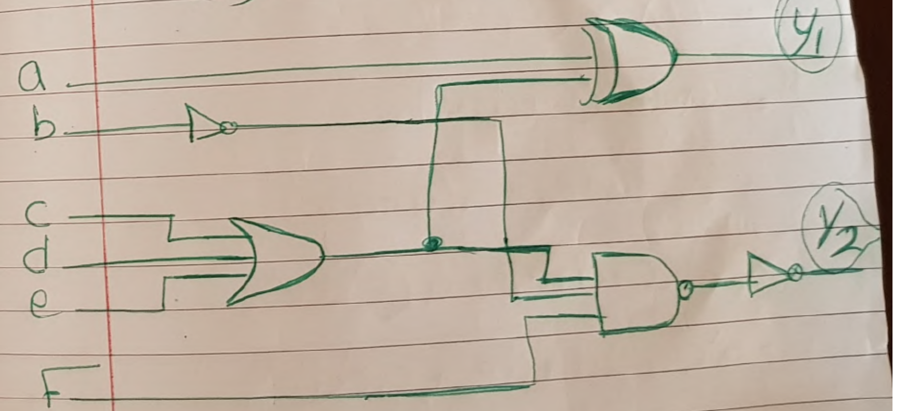
2.28 Write Boolean Expressions & Construct the Truth Tables Describing The outputs of the Circuits Described by the Following logic Diagram

(a)



bc'

(b)



$Y = ((a \cdot e \cdot (bcd)')')'$

$= a \cdot e \cdot (bcd)'$

$= a \cdot e\,(b' + c' + d')$

$= ab'e + ac'e + ad'e$

* Truth Table:

a	b	c	d	e	$ab'e$	$ac'e$	$ad'e$	Y

$Y_1 = a \oplus (c+d+e)$

$= a'(c+d+e) + a(c+d+e)'$

$= a'(c+d+e) + a(c'd'e')$

$\boxed{= a'c + a'd + a'e + ac'd'e'}$

* Truth Table.

a	b	c	d	e	$a'c$	$a'd$	$a'e$	$ac'd'e'$	Y_1

$Y_2 = (((c+d+e) \cdot b' \cdot f)')'$

$= (c+d+e) \cdot b' \cdot f$

$= b'cf + db'f + b'ef$

* Truth Table

b	c	d	f	$b'cf$	$db'f$	$b'ef$	Y_2

Multiplexer

* Multiplexer:
  - Combinational Circuits That Select Binary Information From one of many inputs lines & Directs it To a Single output line.
  - Selection lines used to Control Input lines.
  - $n \longrightarrow$ Selection $\longrightarrow$ used to select Input lines

    $2^n \longrightarrow$ Inputs
  - MUX $\longrightarrow$ (Multiplexer)
  - MUX (4 * 1) = (n * 1)

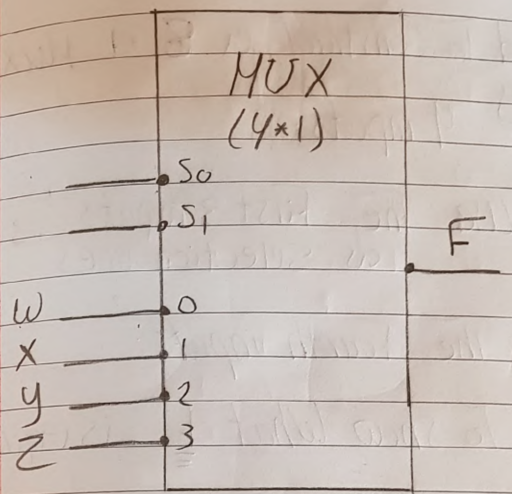
    عدد الInputs   عدد الoutputs

Ex:

MUX (4 * 1)

MUX (8 * 1)

MUX (16 * 1)



4 → Inputs

Selection lines $= \square$

$2^{\square} = 4$

$2^2 = 4$

Selection lines $= 2$

selection lines.		output line.
S0	S1	F
0	0	W
0	1	X
1	0	y
1	1	Z

* بناءً على قيمة ال Selection lines بيتحدد ال output line.

* Number of Selection lines $= 2^{\square} = n \rightarrow$ Inputs.

Ex: 4 inputs.

$2^2 = 4$ Selection lines $= \boxed{2}$

For Ex: We need To Construct a 8 * 1 Mux
By using 4 inputs.

We use The First 3 inputs as Selection lines

& use The Fourth inputs.

To Show What F is equal.

x	y	z	w	F	
0	0	0	0	1	$F = w'$
0	0	0	1	0	
0	0	1	0	0	$F = w$
0	0	1	1	1	
0	1	0	0	0	$F = w$
0	1	0	1	1	
0	1	1	0	1	$F = 1$
0	1	1	1	1	
1	0	0	0	1	$F = w'$
1	0	0	1	0	
1	0	1	0	1	$F = w'$
1	0	1	1	0	
1	1	0	0	1	$F = 1$
1	1	0	1	1	
1	1	1	0	0	$F = w$
1	1	1	1	1	

Selectors: x, y, z

Decoder

* Decoder.
  - Combinational Circuits that convert n input lines to 2^n outputs lines.
  - Decoder is n-to-m line Decoder
    - n → inputs
    - m → outputs.

$$m \leq 2^n$$

- For Ex: DEC (3 * 8)
  - 3 → inputs
  - 8 → outputs.

$n = 3$

$m = 2^3 = 8$

* Decoders With E (Enable) Inputs Can be Connected together To Form large Decoder Circuit.

When $E = 0$ → The Top (First) Decoder is Enabled & The other Decoder is Disabled.

$E = 1$ → The Bottom Decoder is Enabled & The Top Decoder is Disabled.

Inputs			outputs							
X	y	Z	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

Ex: Construct 4 * 16 Decoder with Two 3 * 8 Decoders.

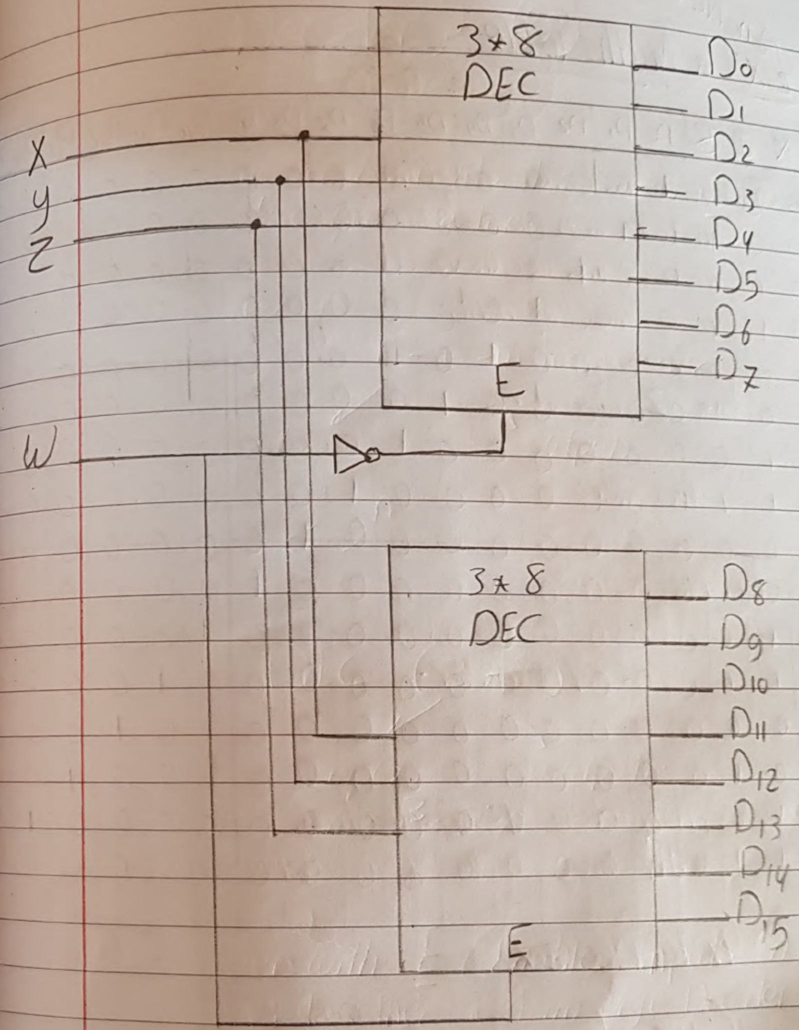
- 4 * 16 $\quad n = 4 \quad m = 2^4 = 16$

using

Two Decoders 3 * 8

$n = 3 \quad m = 2^3 = 8$

- E (Enable line)



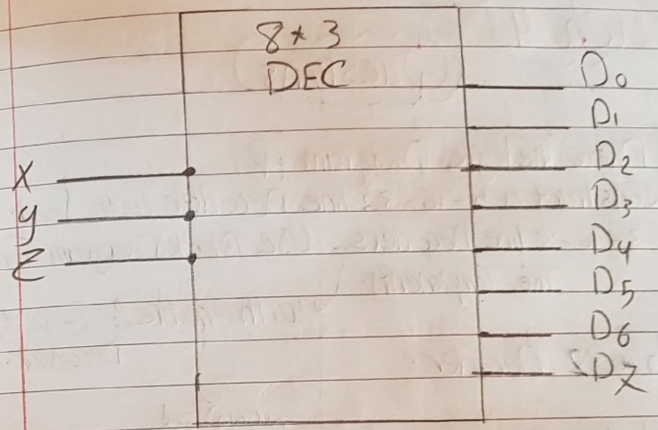
Enable line

* Truth Table

w	x	y	z	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9	D_{10}	D_{11}	D_{12}	D_{13}	D_{14}	D_{15}
0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Ex: Construct 3*8 Decoder.

$n = 3$ $\quad m = 2^3 = 8$



* Truth Table:

x	y	z	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

Ch 4: Questions

4.25 Construct a 5-To-32 line Decoder with Four 3-To-8 line Decoders with enable & 2-To-4 Decoder. Use Block Diagram for The Components.

5 * 32 Decoder.

ليتكون منه

4 Decoders (3 * 8)

Enable

هتكون عبارة عن

2 * 4 Decoder.

4.26 Construct a 4-To-16 line Decoder with Five 2-to-4 Decoders with Enable.

4 * 16 Decoder

لتكون منه

~~8~~ 4 Decoders (2 * 4)

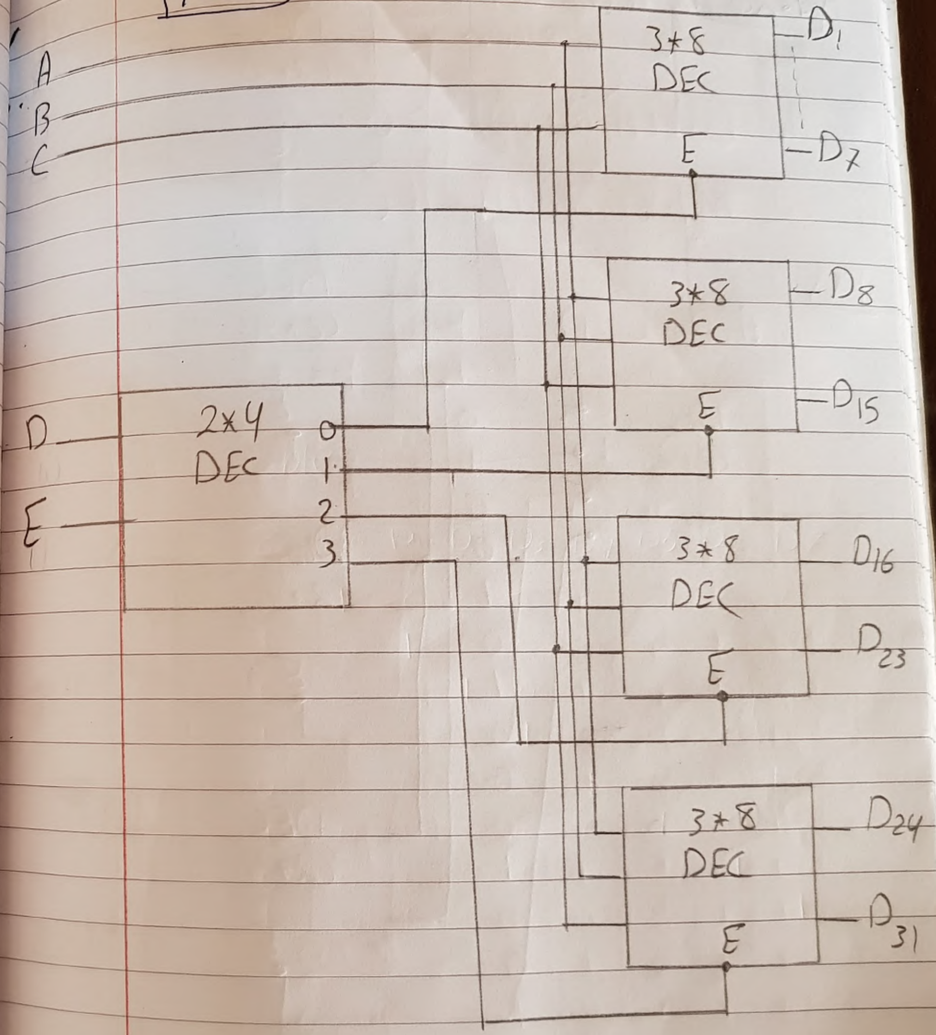
+

- Enable

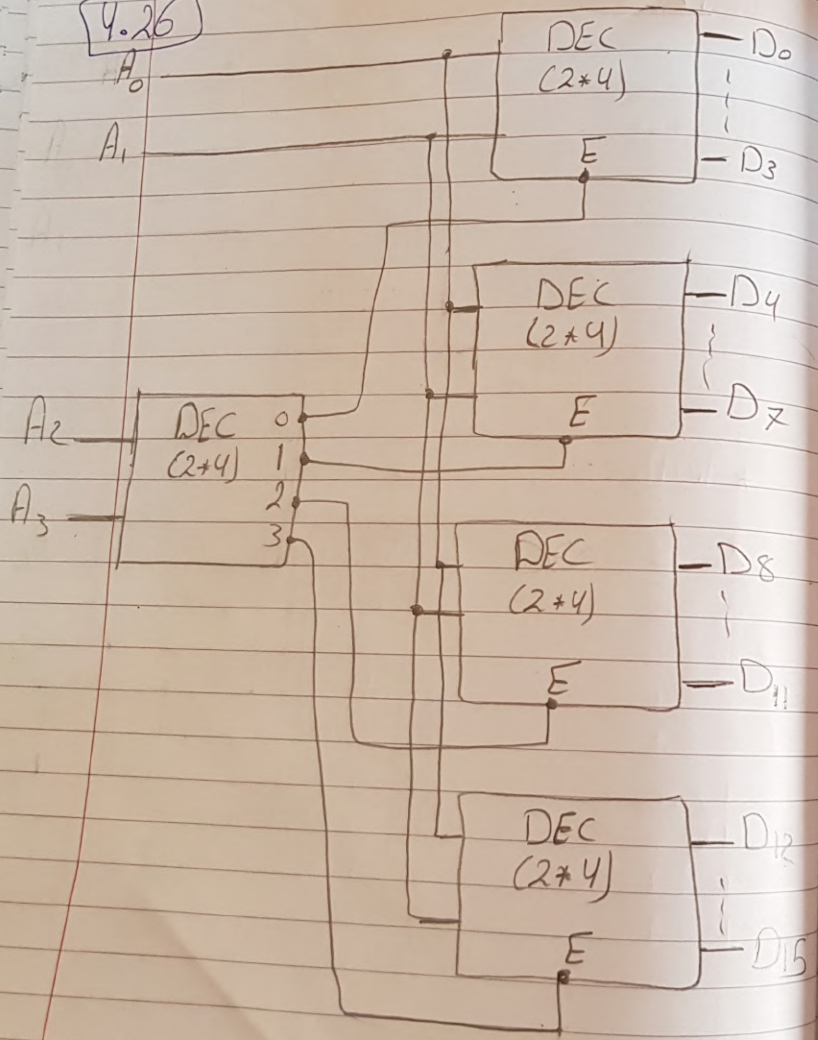
هيكون

1 Decoder (2 * 4).

4.25



4.26



4.31 Construct 16*1 Multiplixer with Two 8*1 & 2*1 Multiplixer Use Block Diagram.

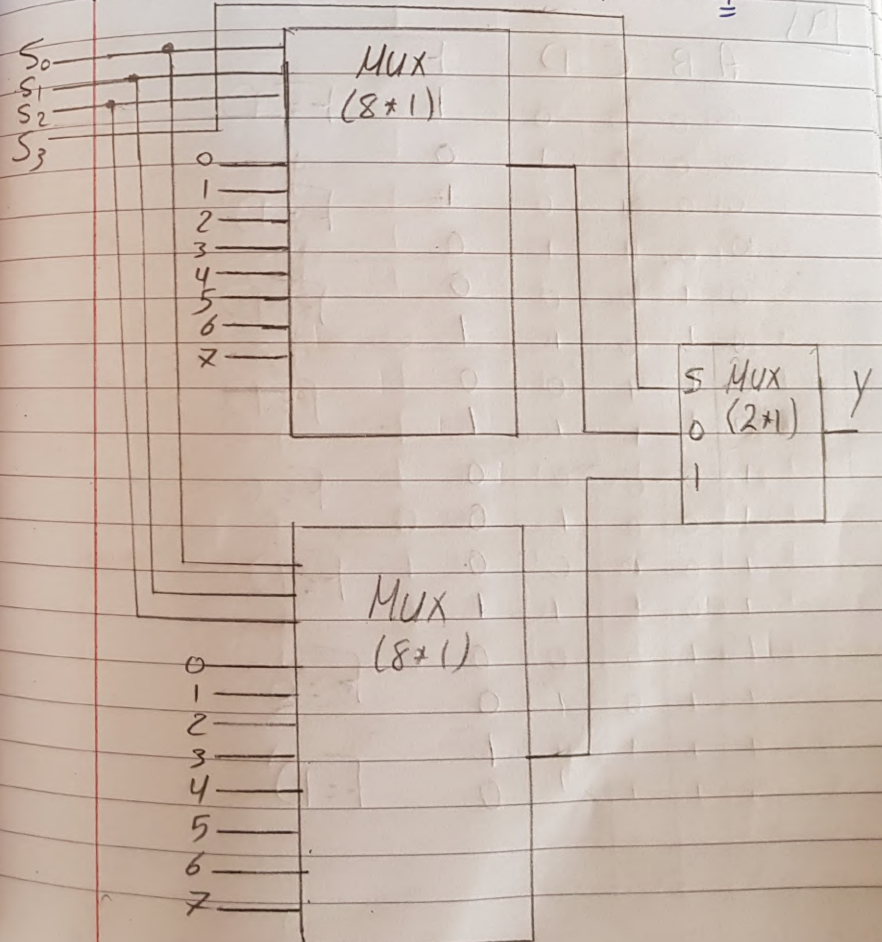
* 16*1 Multiplexer:
  - 1 Mux (8*1)
  - 1 Mux (8*1)
* 1 Mux (2*1)

$n = 16$

selection lines

$\Rightarrow 2^4 = 16$

$S = \underline{\underline{4}}$



4.32 Implement The Following Boolean Function with a Multiplexer.

a) $F(A,B,C,D) = \sum(0,2,5,7,11,14)$

b) $F(A,B,C,D) = \prod(3,8,12)$.

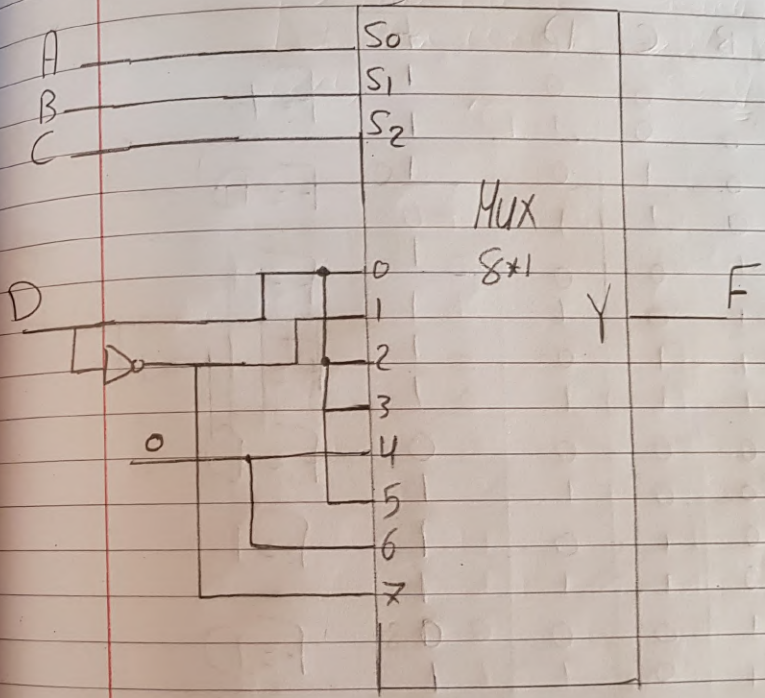
a)

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 = D
0	1	1	1	1	
1	0	0	0	0	F = 0
1	0	0	1	0	
1	0	1	0	0	F = D
1	0	1	1	1	
1	1	0	0	0	F = 0
1	1	0	1	0	
1	1	1	0	1	F = D'
1	1	1	1	0	

8*1 Mux

8 inputs $2^3 = 8$

∴ 3 selectors.



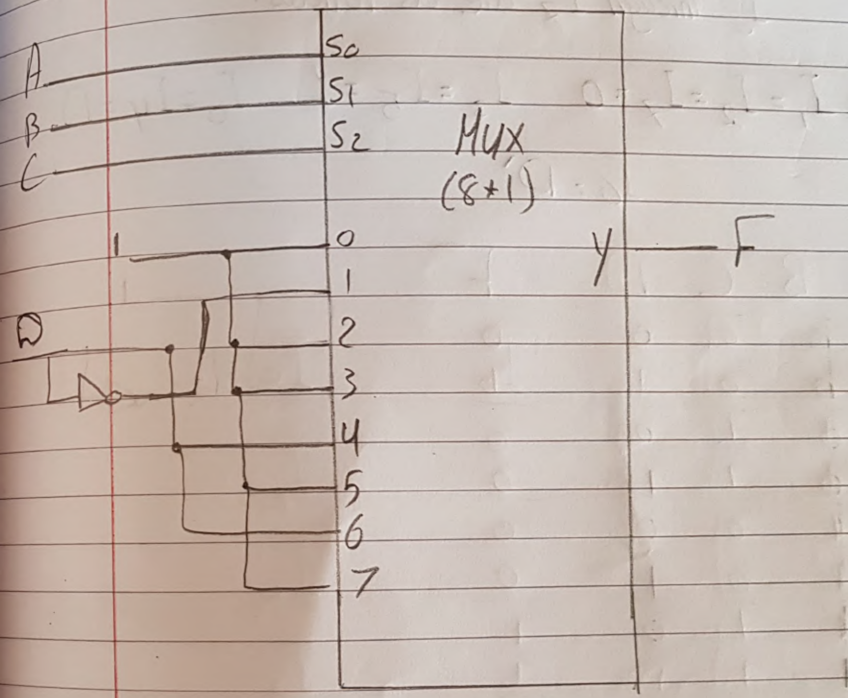
1b) $F = \Pi(3, 8, 12)$

$F' = \Sigma(0, 1, 2, 4, 5, 6, 7, 9, 10, 11, \cancel{12}, 13, 14, 15)$

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

8*1 Mux   8 = inputs

$8 = 2^3$ 3 Selection lines



4.34 An 8×1 Multiplixer has inputs A, B & C Connected to The selection inputs S_2, S_1 & S_0 Respectively. The Data inputs I_0 Through I_7 are as Follows:

(a) $I_1 = I_2 = I_7 = 0$ $\quad I_3 = I_5 = 1$ $\quad I_0 = I_4 = D$

$I_6 = D'$

A	B	C	D	F	
0	0	0	0	0	
0	0	0	1	1	$I_0 = D$
0	0	1	0	0	
0	0	1	1	0	$I_1 = 0$
0	1	0	0	0	
0	1	0	1	0	$I_2 = 0$
0	1	1	0	1	
0	1	1	1	1	$I_3 = 1$
1	0	0	0	0	
1	0	0	1	1	$I_4 = D$
1	0	1	0	1	
1	0	1	1	1	$I_5 = 1$
1	1	0	0	1	
1	1	0	1	0	$I_6 = D'$
1	1	1	0	0	
1	1	1	1	0	$I_7 = 0$

* Determine The Boolean Function that The Multiplixer Implements.

$$F(A, B, C, D) = \sum(1, 6, 7, 9, 10, 11, 12)$$

(b) $I_1 = I_2 = 0$ $\quad I_3 = I_7 = 1$ $\quad I_4 = I_5 = D$

$I_0 = I_6 = D'$

A	B	C	D	F	
0	0	0	0	1	
0	0	0	1	0	$I_0 = D'$
0	0	1	0	0	
0	0	1	1	0	$I_1 = 0$
0	1	0	0	0	
0	1	0	1	0	$I_2 = 0$
0	1	1	0	1	
0	1	1	1	1	$I_3 = 1$
1	0	0	0	0	
1	0	0	1	1	$I_4 = D$
1	0	1	0	0	
1	0	1	1	1	$I_5 = D$
1	1	0	0	1	
1	1	0	1	0	$I_6 = D'$
1	1	1	0	1	
1	1	1	1	1	$I_7 = 1$

$$f(A,B,C,D) = \sum(0,6,7,9,11,12,14,15)$$