* How to implement a Decoder to Convert Binary to octal ?!:

Ans :-

By using (3 - 8) Decoder:-

A	B	C	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

Q4.24)

Design a BCD-to-decimal decoder using the unused combinations of the BCD code as don't-care conditions.

Ans.

BCD	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
0000	0	0	0	0	0	0	0	0	0	1
0001	0	0	0	0	0	0	0	0	1	0
0010	0	0	0	0	0	0	0	1	0	0
0011	0	0	0	0	0	0	1	0	0	0
0100	0	0	0	0	0	1	0	0	0	0
0101	0	0	0	0	1	0	0	0	0	0
0110	0	0	0	1	0	0	0	0	0	0
0111	0	0	1	0	0	0	0	0	0	0
1000	0	1	0	0	0	0	0	0	0	0
1001	1	0	0	0	0	0	0	0	0	0

D9= 9 + Σd(10,11,12,13,14,15) , D8=8 + Σd(10,11,12,13,14,15)

D7= 7 + Σd(10,11,12,13,14,15) , D6=6 + Σd(10,11,12,13,14,15)

D5= 5 + Σd(10,11,12,13,14,15) , D4=4 + Σd(10,11,12,13,14,15)

D3= 3 + Σd(10,11,12,13,14,15) , D2=2 + Σd(10,11,12,13,14,15)

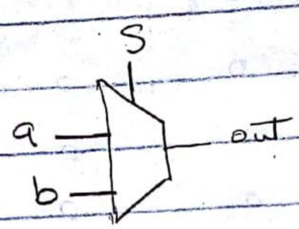
D1= 1 + Σd(10,11,12,13,14,15) , D0=0 + Σd(10,11,12,13,14,15)

Ab/ /cd	00	01	11	10
00	D0	D4	x	D8
01	D1	D5	x	D9
11	D3	D7	x	x
10	D2	D6	x	x

D0= a'b'c'd' D1= A'B'C'D D2= B'CD' D3= B'CD D4=BC'D' D5=BC'D D6=BCD'
D7= BCD D8=AD' D9= AD

* Multiplexer (Mux)

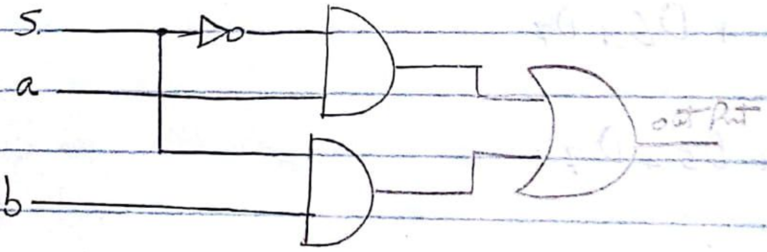
↳ Called (data selector)
↳ switch passes one of its input through outputs by using select line (S)



S	output
0	a
1	b

S	a	b	output
0	0	X	0
0	1	X	1
1	X	0	0
1	X	1	1

$output = \bar{S}a + Sb$



2^n input ⇒ n select line.
2 input ⇒ 1 select line (Called 2 to 1 Mux)
4 input → 2 select line (Called 4 to 1 Mux)
8 input → 3 select line (Called 8 to 1 Mux)

(8 → no. of input; 1 → one output)
or (8×1) Mux.

⇐ الـ (Multiplexer) دائماً اله عدد (output) واحد
فقط (one output).

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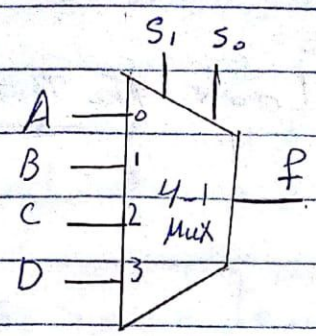
* 4 to 1 MUX:



S_1	S_0	f
0	0	A
0	1	B
1	0	C
1	1	D

$$f = A S_1 S_0' + B S_1 S_0 + C S_1 S_0' + C S_1 S_0' + D S_1 S_0$$

Very important

* Implement The Boolean Function using MUX:

EX.

$f(x,y,z) = \sum m(1,2,6,7)$

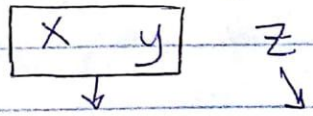
Implement the boolean fun. using MUX.

ANS.

① أولاً نبني الـ Truth table لـ (f)

S_1	S_0	x	y	z	f	
0	0	0	0	0	0	f = z
		0	0	1	1	
0	1	0	1	0	1	= z'
		0	1	1	0	
1	0	1	0	0	0	= 0
		1	0	1	0	
1	1	1	1	0	1	= 1
		1	1	1	1	

② نحدد الـ (select lines)

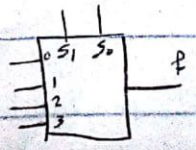


Select lines. Data line.

S_1 S_0

③ نحدد نوع الـ (MUX) من عدد الـ Select line

2 select line $\Rightarrow 2^n \rightarrow$ 4 inputs



Date

④ ثم نقسم الـ Truth Table حسب قيم $S_1\ S_0$

أو

0	0	→ 0
0	1	→ 1
1	0	→ 2
1	1	→ 3

---

⑤ نحسب (f) بالنسبة لـ (Z) عندما :- $S_1\ S_0$ بـ 0

وعندما بـ 1

وعندما بـ 2

وعندما بـ 3

عندما $S_1\ S_0$ بـ 0 ← نلاحظ أن :-

قيم $f = Z$

وعندما $S_1\ S_0$ بـ 1 ←

قيم $f = Z'$

وعندما $S_1\ S_0$ بـ 2 ←

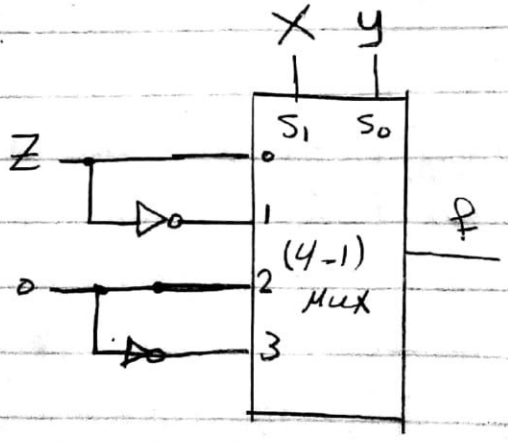
قيم $f = 0$

وعندما $S_1\ S_0$ بـ 3 ←

قيم $f = 1$

---

⑥ ثم نركب الـ (MUX) ونضع قيم الـ (inPuts) عليه :-



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Ex:

Implement $f(a,b,c) = \Sigma m(0,3,5,6)$ using Multiplexer

Ans:

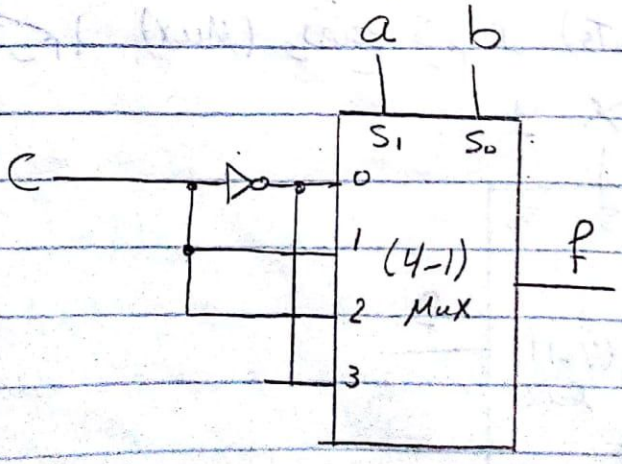
a	b	c	f	
0	0	0	1	$f = \bar{c}$
0	0	1	0	
0	1	0	0	$f = c$
0	1	1	1	
1	0	0	0	$f = c$
1	0	1	1	
1	1	0	1	$f = \bar{c}$
1	1	1	0	

a b → Select lines S_1 S_0

c → Data line.

2 select line → 4 input

↳ (4-1) MUX.



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* Implement The function: $f(A,B,C,D) = \sum m(1,3,4,11,12,13,14,15)$ using (8 X 1) MuX.

Ans.

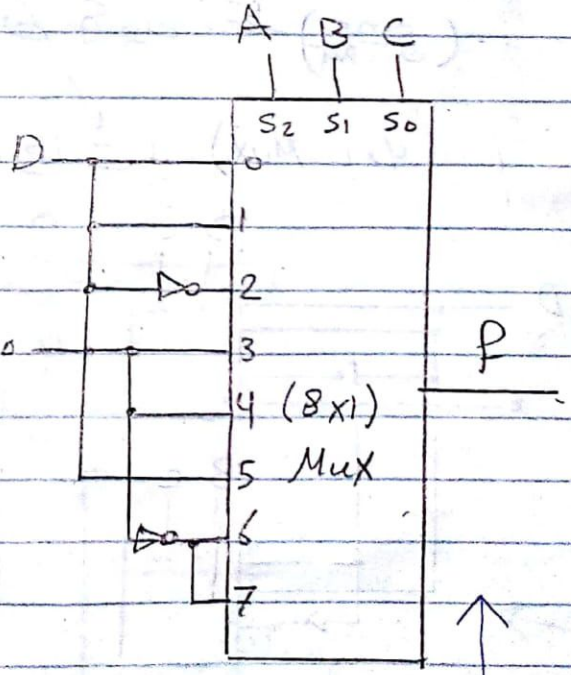
Select lines.

S_2 A	S_1 B	S_0 C	D	f	
0	0	0	0	0	f = D
0	0	0	1	1	
0	0	1	0	0	f = D
0	0	1	1	1	
0	1	0	0	1	f = D'
0	1	0	1	0	
0	1	1	0	0	f = 0
0	1	1	1	0	
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	1	f = 1
1	1	0	1	1	
1	1	1	0	1	f = 1
1	1	1	1	1	

A B C D

select lines — Data line

3 select line $= 2^3 = 8$ inputs.



Q(4-3-4)

Ex:

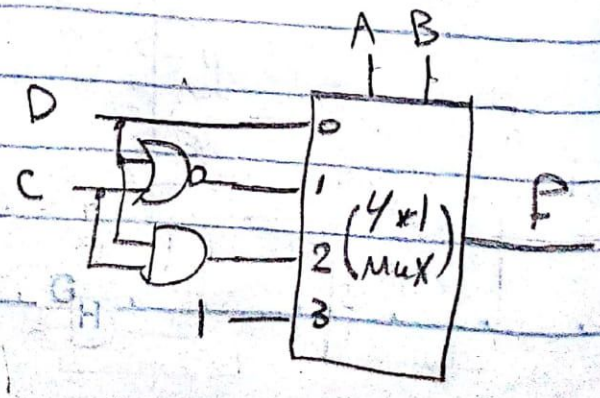
* Implement The function $f(A,B,C,D) = \sum m(1,3,4,11,12,13,14,15)$ using (4 * 1) MuX and external gates.

← لعين المثال السابق والذي يجب أن نحله بـ (8-1) MuX يريدنا أن نحله باستخدام (4*1) MuX

ANS

(4*1) MUX → has 2 select lines.

select line A	select line B	Data C	Data D	F	
0	0	0	0	0	When $\bar{A}\bar{B}$ = 00
0	0	0	1	1	$F = D$
0	0	1	0	0	
0	0	1	1	1	
0	1	0	0	1	When $\bar{A}B$ = 01
0	1	0	1	0	$F = \bar{C}\bar{D} = (C+D)'$
0	1	1	0	0	
0	1	1	1	0	
1	0	0	0	0	
1	0	0	1	0	When A B = 10
1	0	1	0	0	$F = C\bar{D}$
1	0	1	1	1	
1	1	0	0	1	
1	1	0	1	1	When A B = 11
1	1	1	0	1	$F = 1$
1	1	1	1	1	



Q(1-31)

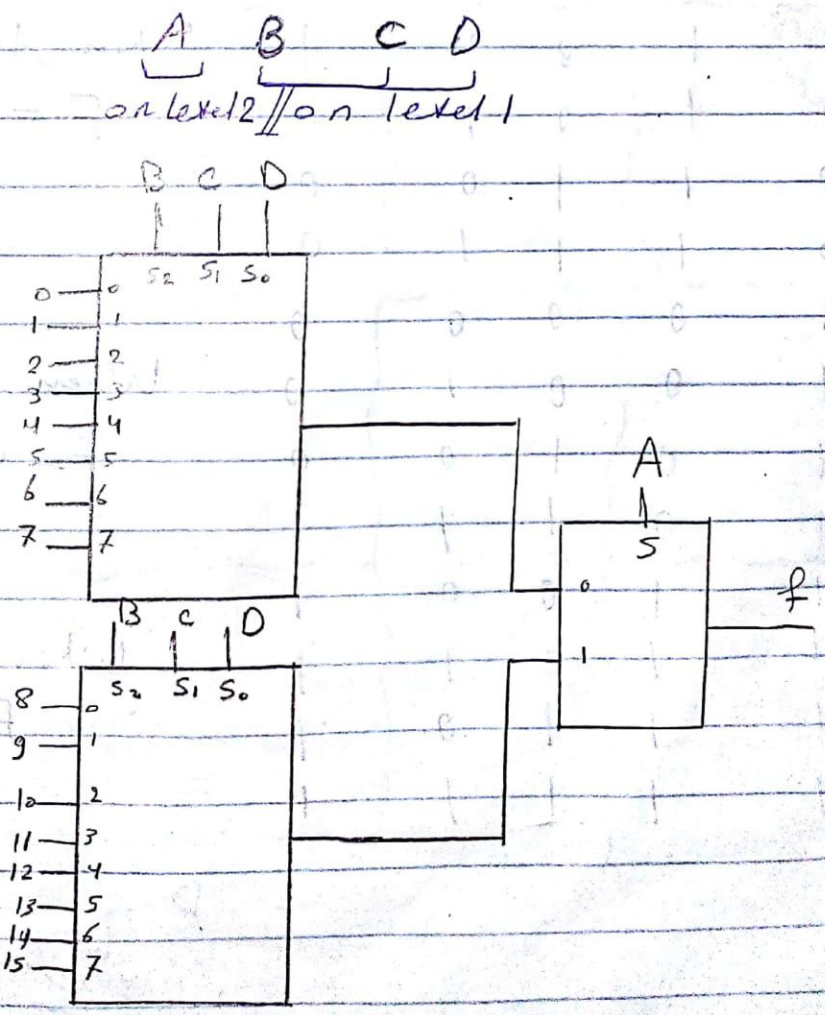
↳ Construct (16*1) Mux with two (8*1) Mux and one (2*1) Mux. use block diagram:.

ANS.

① نضبط الـ (inputs) ⟸ 16/8 ⟹ two of (8*1) Mux.

② نضبط الـ (outputs) بأن يخرج لـ one (2*1) Mux.

③ نضبط الـ (select line). حيث أن الـ (16*1) لديه 4 select line (A, B, C, D.)
وأن الـ (8*1) لديه 3 select line



4.32)

Implement the following Boolean function with a multiplexer:

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

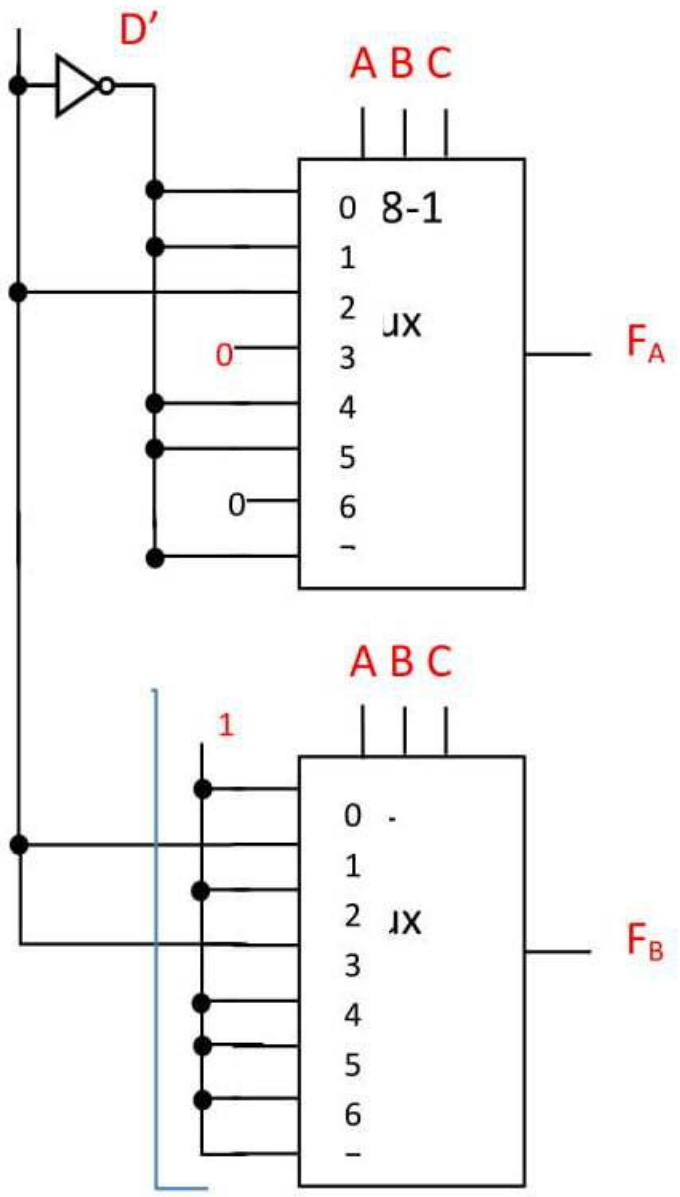
(b) $F(A, B, C, D) = \Pi M(2, 6, 11) =$

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

$F = \Sigma m(0,1,3,4,5,7,8,9,10,12,13,14,15)$

Ans.

ABC	D	FA		FB	
000	0	1	D′	1	1
000	1	0		1	
001	0	1	D′	0	D
001	1	0		1	
010	0	0	D	1	1
010	1	1		1	
011	0	0	0	0	D
011	1	0		1	
100	0	1	D′	1	1
100	1	0		1	
101	0	1	D′	1	D′
101	1	0		0	
110	0	0	0	1	1
110	1	0		1	
111	0	1	D′	1	1
111	1	0		1	

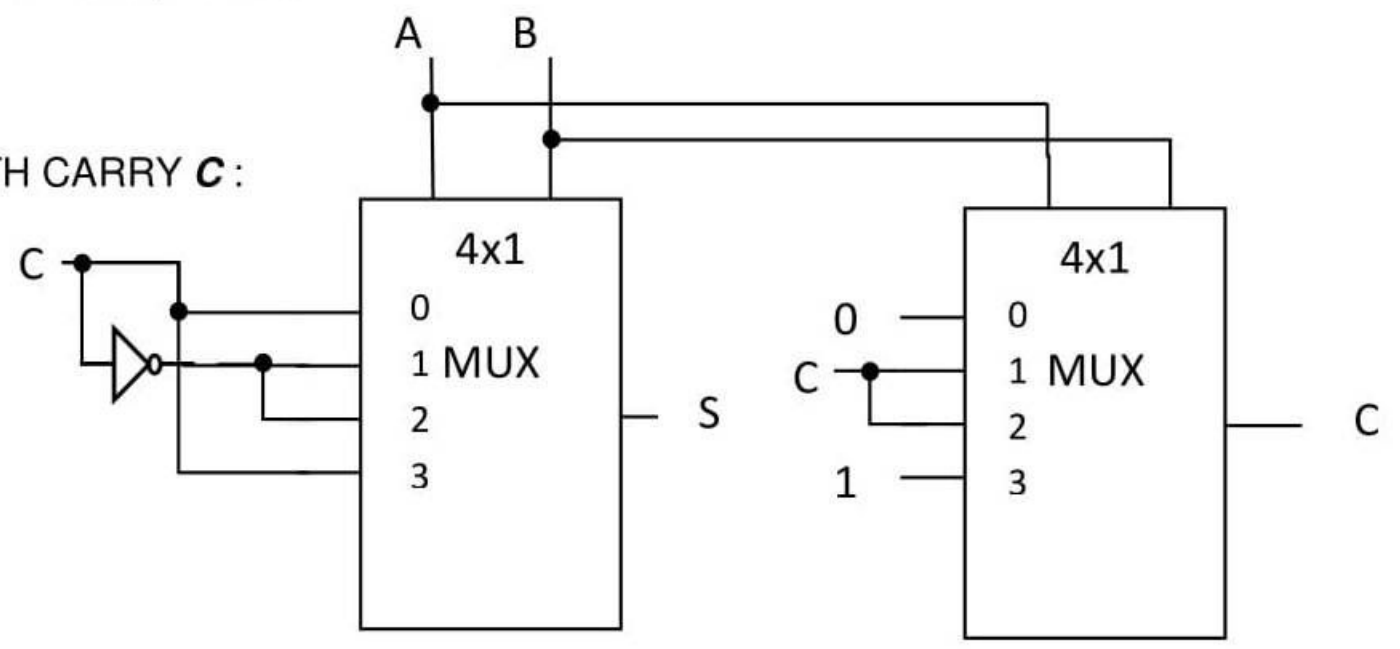


Q4.33) Implement a full adder with two 4 X 1 multiplexers.

Ans.

FULL ADDER THAT ADDS ***A*** and ***B*** WITH CARRY ***C*** :

A	B	C	S	F_S	Co	F_{Co}
0	0	0	0	C	0	0
0	0	1	1		0	
0	1	0	1	C′	0	C
0	1	1	0		1	
1	0	0	1	C′	0	C
1	0	1	0		1	
1	1	0	0	C	1	1
1	1	1	1		1	



Q4.34)

An 8 X 1 multiplexer has inputs A , B , and C connected to the selection inputs S_2 , S_1 , and S_0 , respectively. The data inputs I_0 through I_7 are as follows:

(a) $I_1 = I_2 = I_7 = 0$; $I_3 = I_5 = 1$; $I_0 = I_4 = D$; and $I_6 = D'$.

(b) $I_1 = I_2 = 0$; $I_3 = I_7 = 1$; $I_4 = I_5 = D$; and $I_0 = I_6 = D'$.

Determine the Boolean function that the multiplexer implements.

Ans.

	Select lines			Data line	Fa	Fb
I	A	B	C	D		
I0	0	0	0	0	0	1
	0	0	0	1	1	0
I1	0	0	1	0	0	0
	0	0	1	1	0	0
I2	0	1	0	0	0	0
	0	1	0	1	0	0
I3	0	1	1	0	1	1
	0	1	1	1	1	1
I4	1	0	0	0	0	0
	1	0	0	1	1	1
I5	1	0	1	0	1	0
	1	0	1	1	1	1
I6	1	1	0	0	1	1
	1	1	0	1	0	0
I7	1	1	1	0	0	1
	1	1	1	1	0	1

Fa = Σm(1,6,7,9,10,11,12)

Fb = Σm(0,6,7,9,11,12,14,15)

Then derive the Boolean function using K-map

AB/ /CD	00	01	11	10
00			1	
01	1			1
11		1		1
10		1		1

$F_A = B'C'D + ABC'D' + A'BC + AB'C$

$F_B = \Sigma m(0, 6,7,9,11,12,14,15)$

AB/ /CD	00	01	11	10
00	1		1	
01				1
11		1	1	1
10		1	1	

$F_B = A'B'C'D' + AB'D + BC + ABD'$