CS2100

TUTORIAL #8

MSI COMPONENTS

(PREPARED BY: AARON TAN)

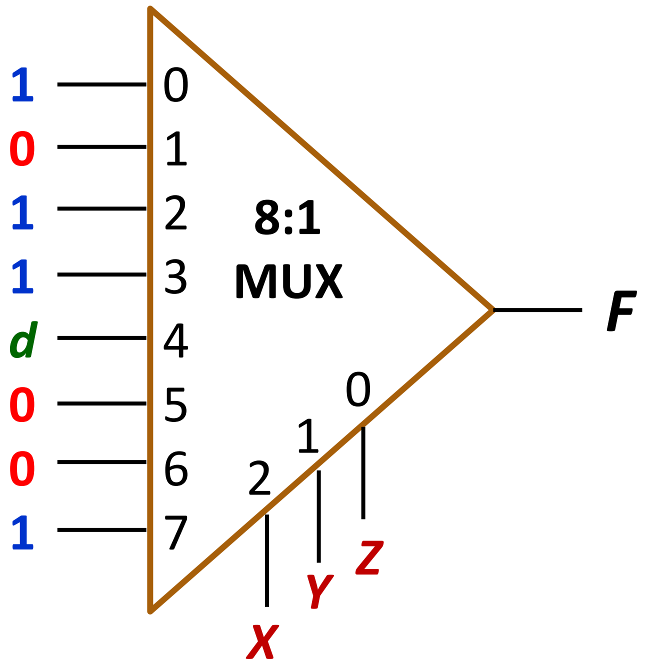
Q1. $F(X,Y,Z) = \prod M(1,5,6) \cdot D(4)$

X	Y	Z	F
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	*d*
1	0	1	0
1	1	0	0
1	1	1	1

Using *d* instead of *X* for don't care to avoid confusion with input *X*.

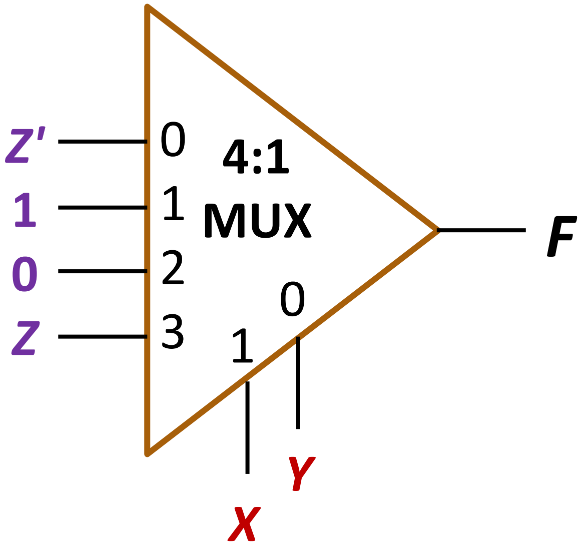
Q1. $F(X,Y,Z) = \prod M(1,5,6) \cdot D(4)$

X	*Y*	*Z*	*F*
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	*d*
1	0	1	0
1	1	0	0
1	1	1	1



Q1. $F(X,Y,Z) = \prod M(1,5,6) \cdot D(4)$

X	*Y*	*Z*	*F*	*F*
0	0	0	1	*Z'*
0	0	1	0	
0	1	0	1	**1**
0	1	1	1	
1	0	0	*d*	**0** or ~~*Z'*~~
1	0	1	0	
1	1	0	0	*Z*
1	1	1	1	

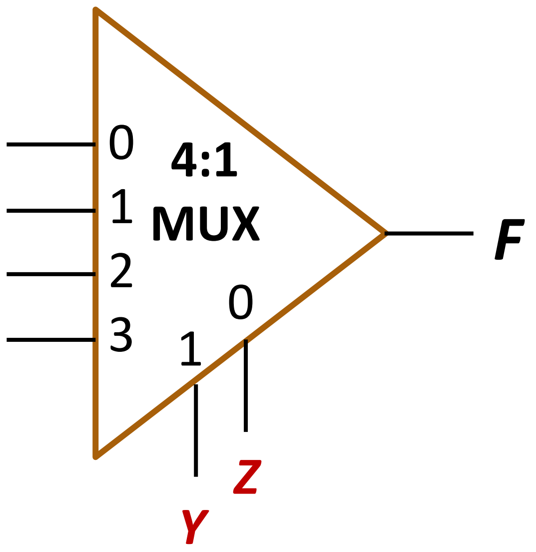


The question prefers constants over literals.

Q1. $F(X,Y,Z) = \prod M(1,5,6) \cdot D(4)$

X	Y	Z	F
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	d
1	0	1	0
1	1	0	0
1	1	1	1

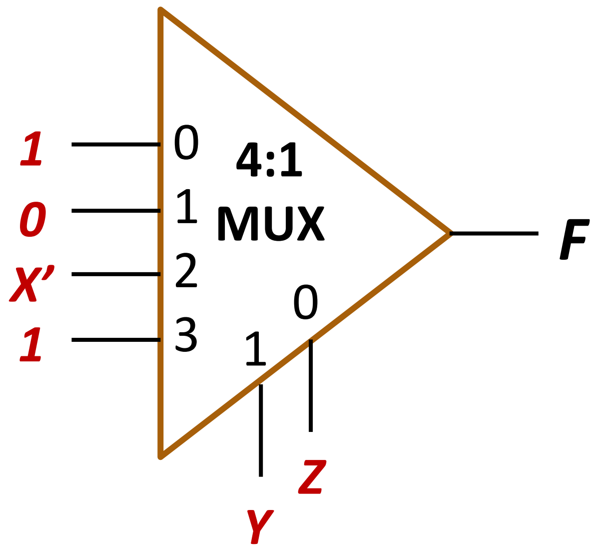
What if we change the selector lines to *YZ*?



Q1. $F(X,Y,Z) = \prod M(1,5,6) \cdot D(4)$

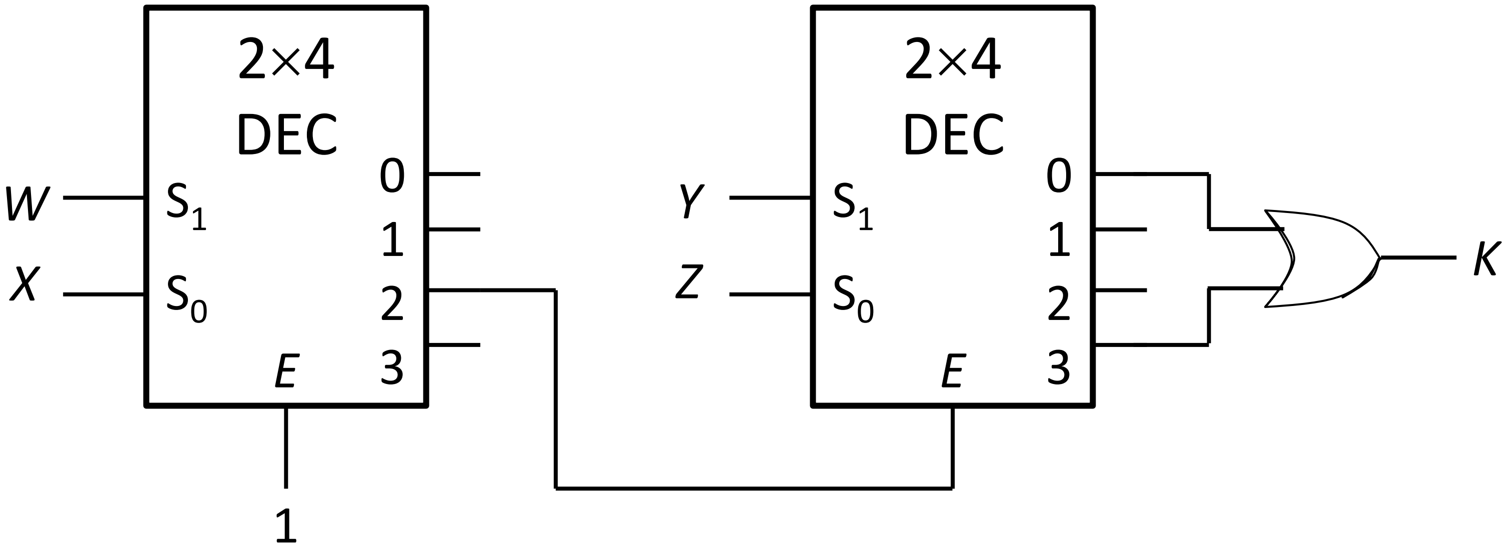
X	Y	Z	F
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	d
1	0	1	0
1	1	0	0
1	1	1	1

What if we change the selector lines to *YZ*?



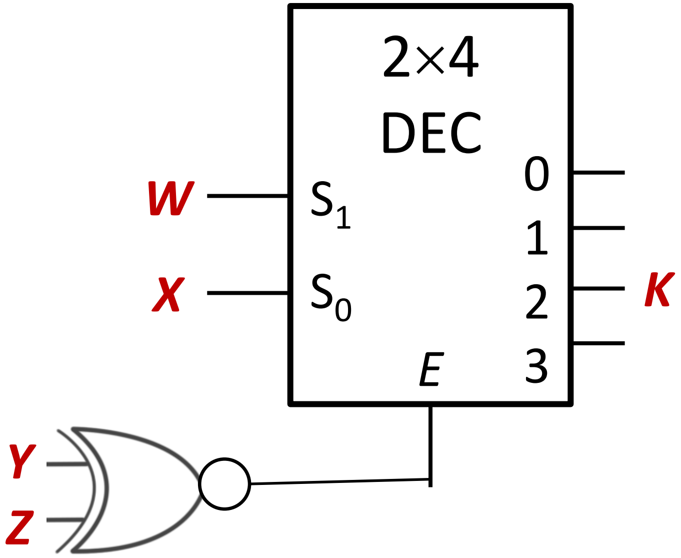
Just reorder the rows and apply the same process.

Q2. $K(W,X,Y,Z) = \Sigma\, m(8,11)$



m8 is 1000 m9 is 1001

m11 is 1011 m10 is 1010



Q3.

What is your observation?

A	B	C	D	F	G	H
0	0	0	0	0	0	0
1	0	0	0	0	0	1
1	1	0	0	0	1	0
1	1	1	0	0	1	1
1	1	1	1	1	0	0
0	1	1	1	1	0	1
0	0	1	1	1	1	0
0	0	0	1	1	1	1

Four 0s, Zero 1s

Three 0s, One 1s

Two 0s, Two 1s

One 0s, Three 1s

Zero 0s, Four 1s

One 0s, Three 1s

Two 0s, Two 1s

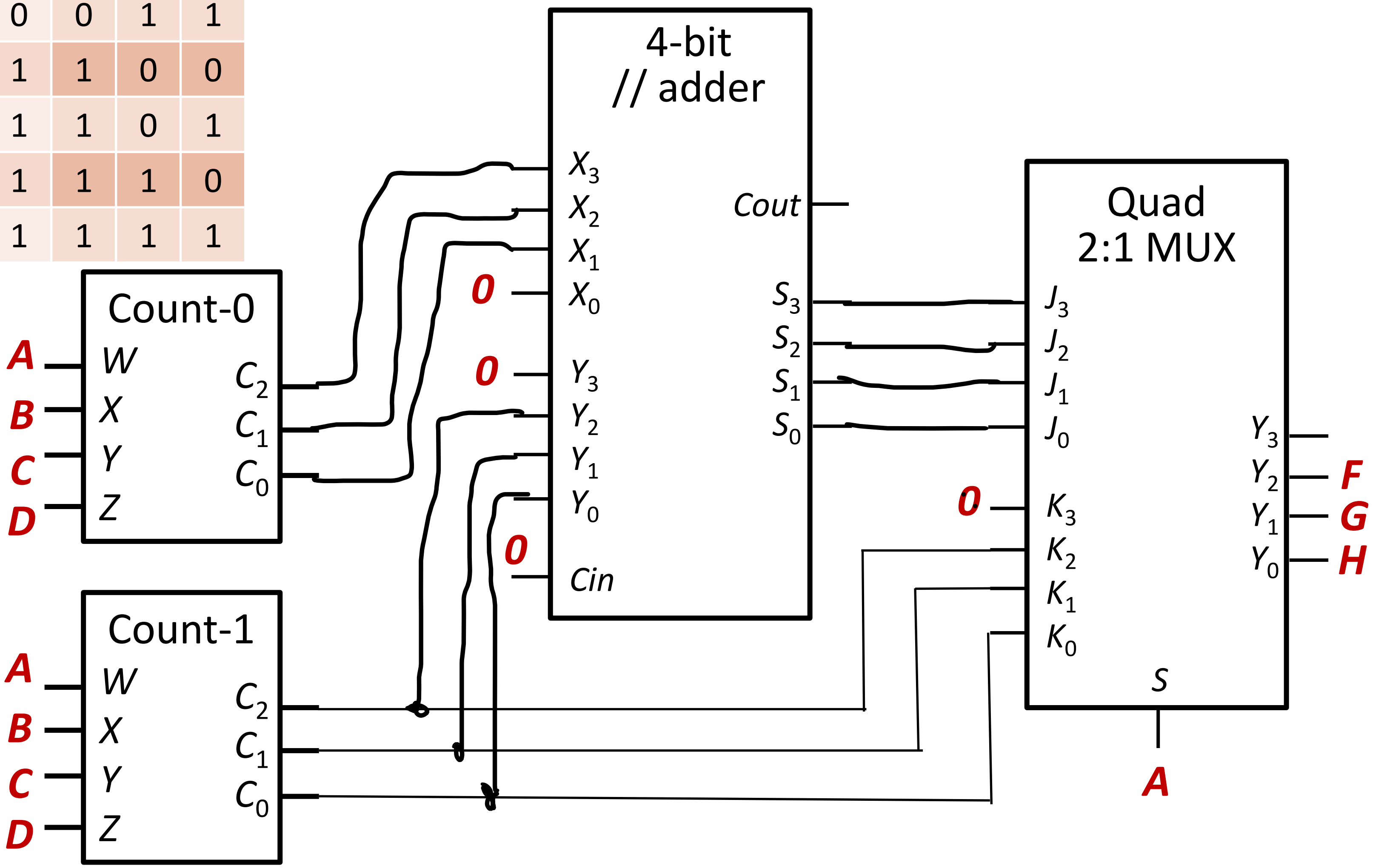
Three 0s, One 1s

Q3.

A	B	C	D	F	G	H
0	0	0	0	0	0	0
1	0	0	0	0	0	1
1	1	0	0	0	1	0
1	1	1	0	0	1	1
1	1	1	1	1	0	0
0	1	1	1	1	0	1
0	0	1	1	1	1	0
0	0	0	1	1	1	1

Ideas:

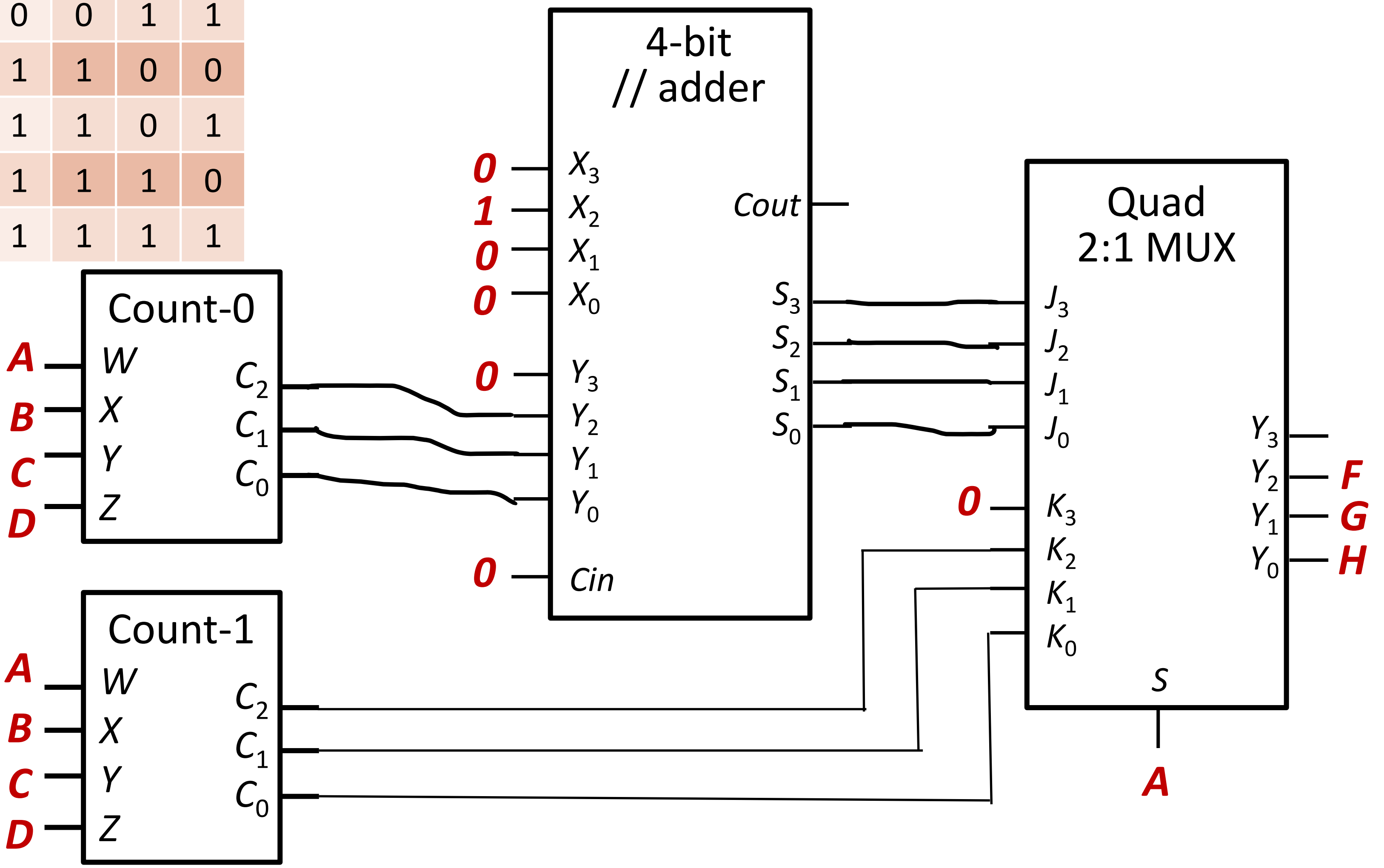
1. If A=1 (or D=0), count #1s in $ABCD$.
2. If A=0 (or D=1), #1s + 2 × #0s.



Q3.

A	*B*	*C*	*D*	*F*	*G*	*H*
0	0	0	0	0	0	0
1	0	0	0	0	0	1
1	1	0	0	0	1	0
1	1	1	0	0	1	1
1	1	1	1	1	0	0
0	1	1	1	1	0	1
0	0	1	1	1	1	0
0	0	0	1	1	1	1

Ideas:
1. If A=1 (or D=0), count #1s in *ABCD*.
2. If A=0 (or D=1), 4 + #0s..



Q4. $F(A,B,C,D) = \sum m(0,1,3,4,6,7,8,9,11,12,14,15)$

F

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

$F = C' \cdot D' + B \cdot C + \ldots$

Too long!

Q4. $F(A,B,C,D) = \Sigma\, m(0,1,3,4,6,7,8,9,11,12,14,15)$

Let's implement *F'* instead and then invert it!

F

1	1	1	0
1	0	1	1
1	0	1	1
1	1	1	0

C, *B*, *A*, *D*

F'

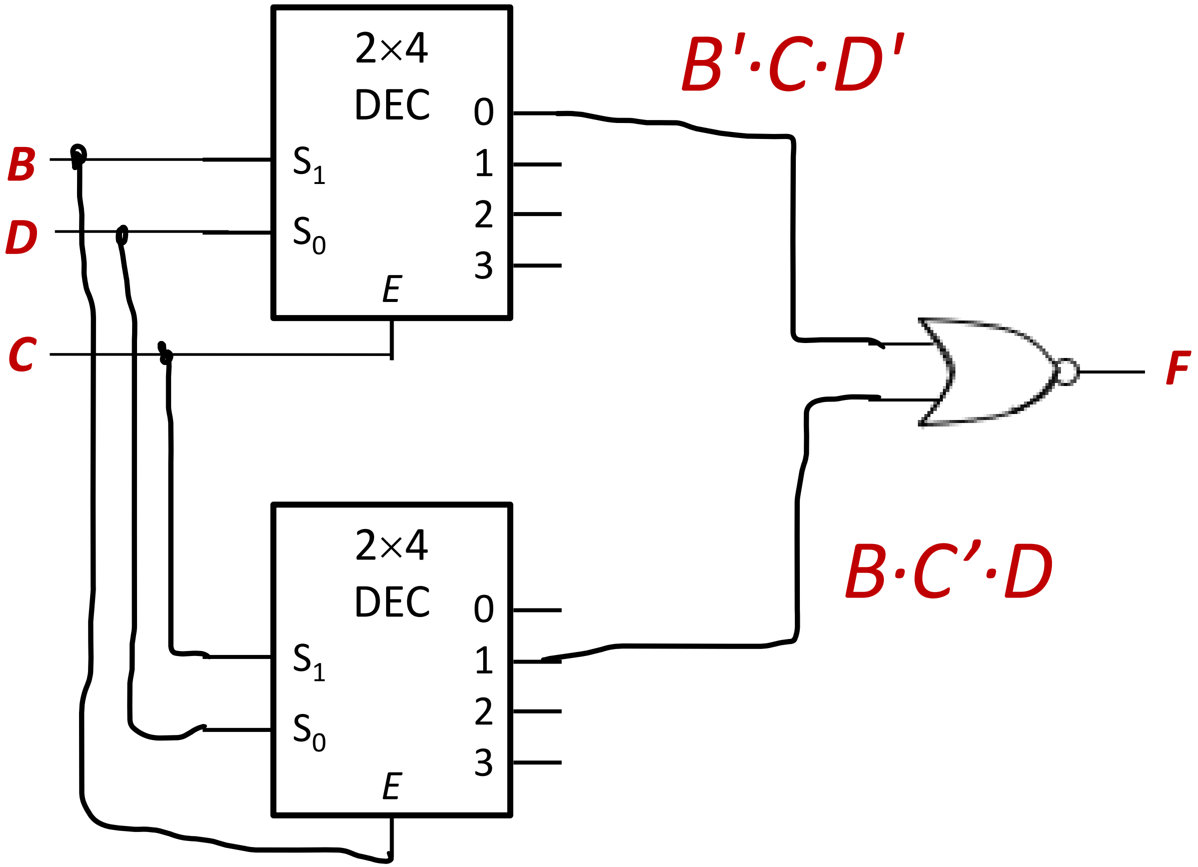
0	0	0	1
0	1	0	0
0	1	0	0
0	0	0	1

C, *B*, *A*, *D*

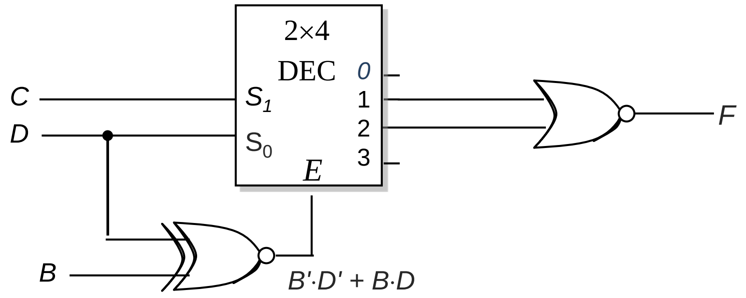
$F' = B{\cdot}C'{\cdot}D + B'{\cdot}C{\cdot}D'$

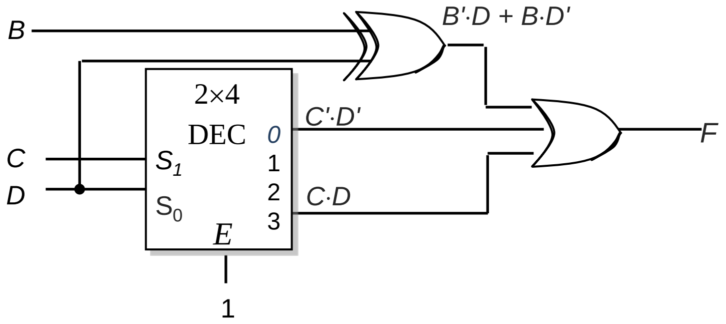
Q4. $F(A,B,C,D) = \Sigma\, m(0,1,3,4,6,7,8,9,11,12,14,15)$

$F' = B \cdot C' \cdot D + B' \cdot C \cdot D'$



Alternative Answers





$F' = (B'D' + BD)(C'D + CD')$

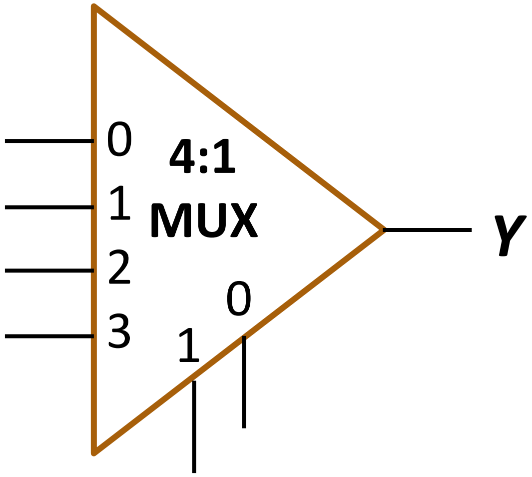
$F = B'D + BD' + C'D' + CD$

END OF FILE

Additional Question 1

Implement the function Y = AB’ + B’C’ + A’BC using only a 4:1 multiplexer. Assume that complemented variables and logic constants are available.

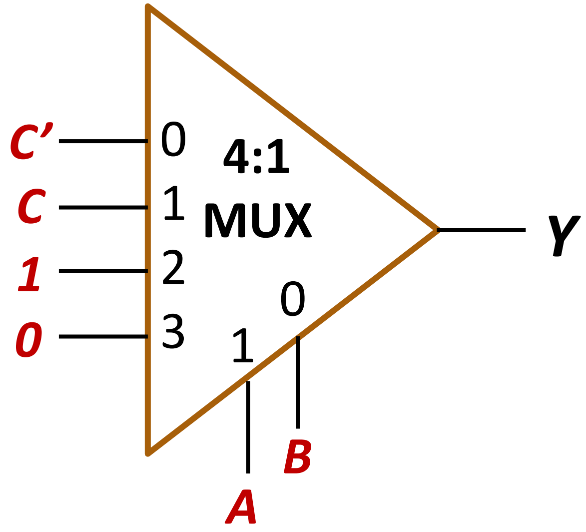
A	*B*	*C*	*Y*
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0



Answer

Implement the function Y(A,B,C) = AB' + B'C' + A'BC using only a 4:1 multiplexer. Assume that complemented variables and logic constants are available.

A	B	C	Y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0



Can choose to use AB or BC or AC for the multiplexer control.

Input assignment changes based on control signals chosen. There could be better solutions if you choose something more sensible.

Additional Question 2

Implement the function F = Σ *m(1, 9)* using only a 2x4 decoder. Other logic gates and complemented inputs are not available.

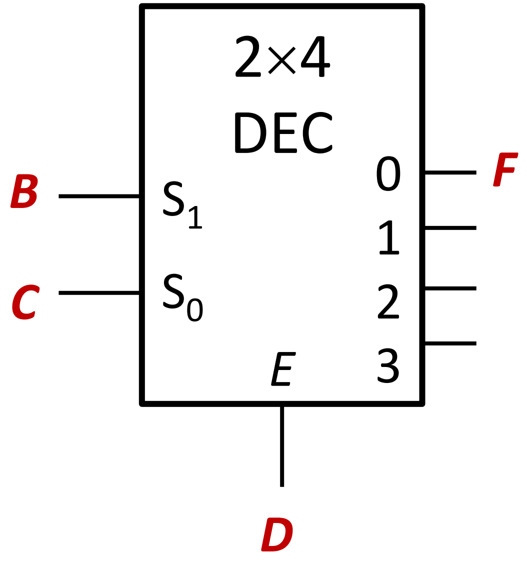
Answer

Implement the function F(A,B,C,D) = $\Sigma\ m(1, 9)$ using only a 2x4 decoder (with enable). Other logic gates and complemented inputs are not available.

A	B	C	D	Y
0	0	0	1	1
0	0	1	1	0
0	1	0	1	0
0	1	1	1	0
1	0	0	1	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	0

If we choose D for enable, we can instantly reject all the even numbers.

Looking only at ABC for m1 and m9, we accept if BC = 00.



Additional Question 3

Refer to the diagram for a multiplexer on the right.

What is the minimum number of bits needed for S?

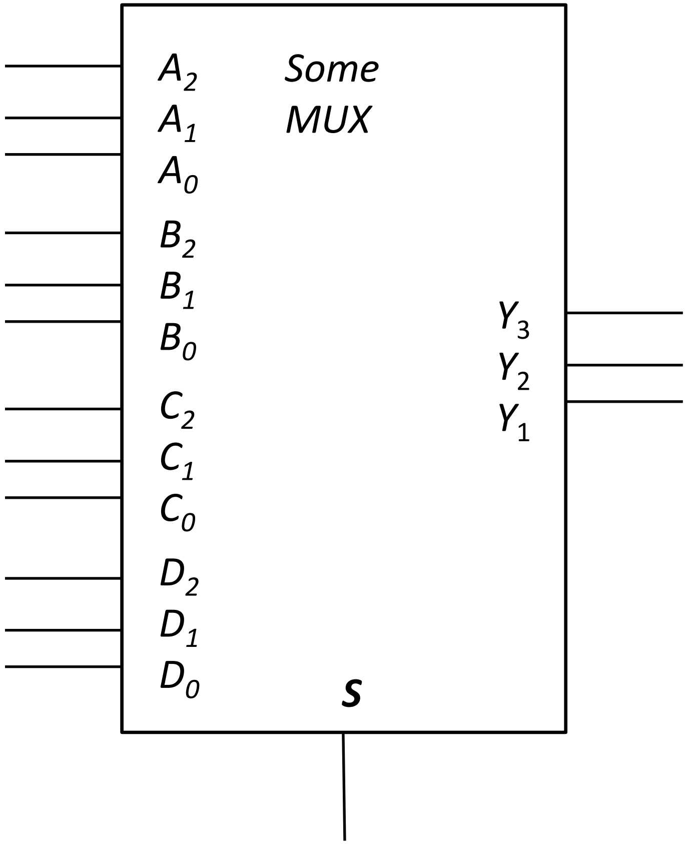
A) 1

B) 2

C) 3

D) 4

E) None of the above



Answer

Refer to the diagram for a multiplexer on the right.

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A) 1

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C) 3

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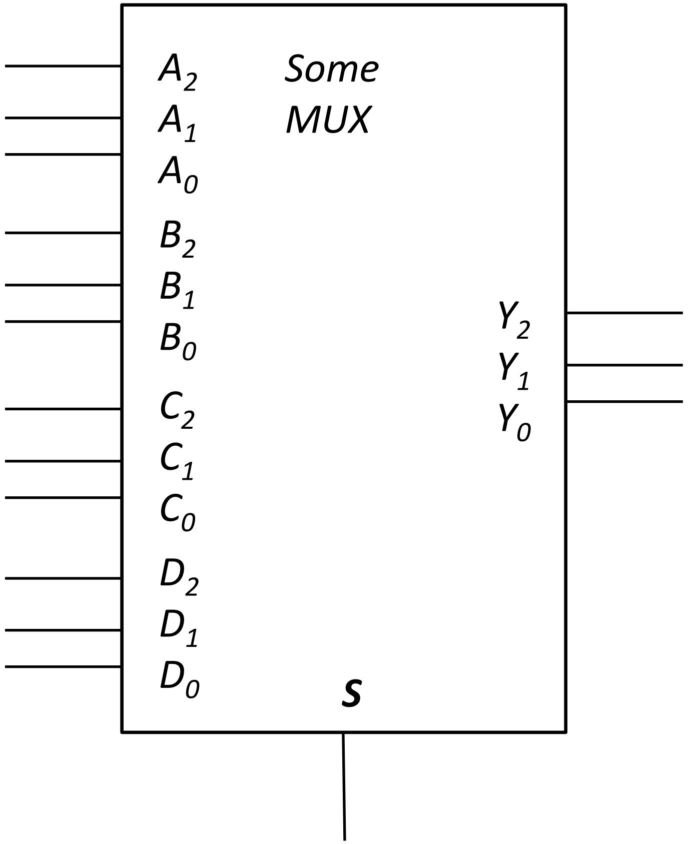
E) None of the above.



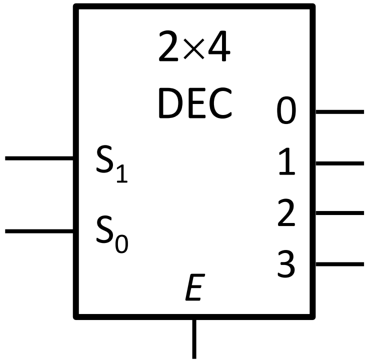
B. Selecting from 4 inputs, S should have $\log_2 4 = 2$ bits

Additional Question 4

It is possible to use only the 2 x 4 decoder (no negated literals) to implement the function

$F(A, B, C) = A'\cdot B'\cdot C'$

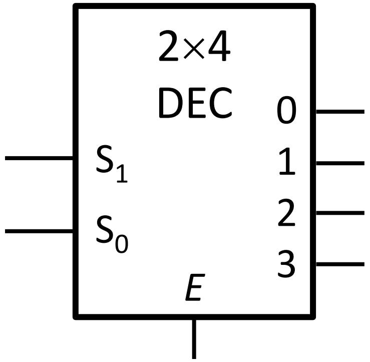
Is this statement true or false? Justify your answer.



Answer

It is possible to use only the 2 x 4 decoder (no negated literals) to implement the function

$F(A, B, C) = A' \cdot B' \cdot C'$



Is this statement true or false? Justify your answer.

False.

We need to use all three variables as inputs to the decoder.

Otherwise, F = 0 for all inputs (if you fix E = 0) or there are at least two inputs where F = 1 (if you fix E = 1 or S1 or S0 to some constant).

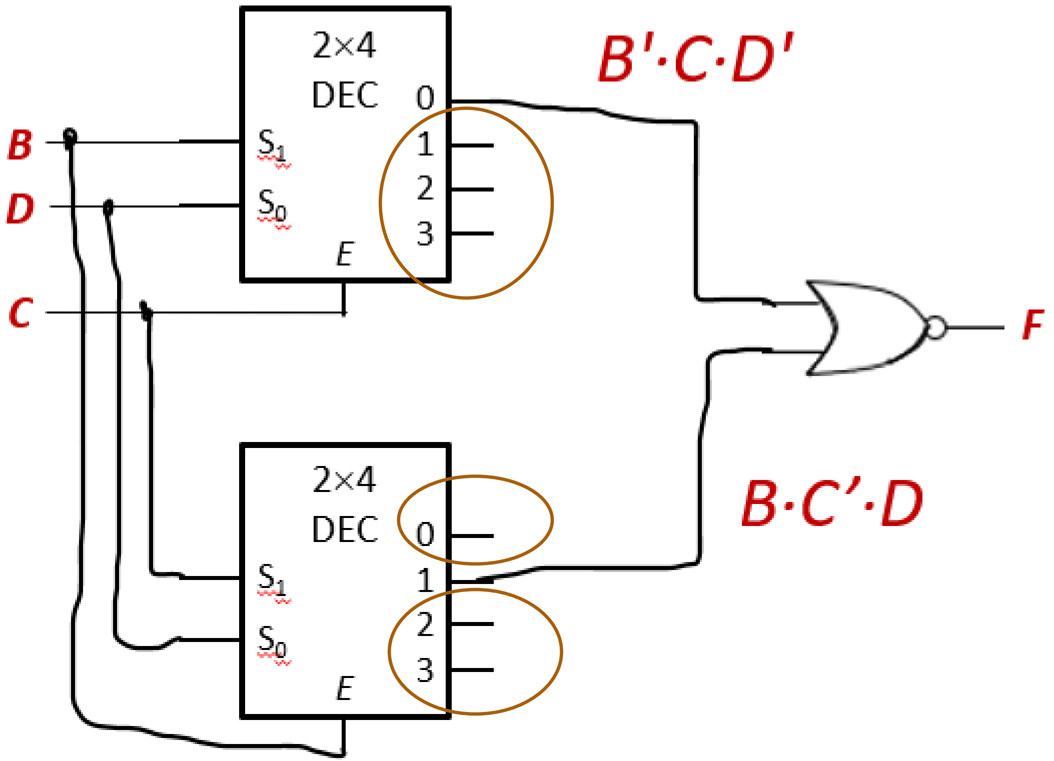
Since we need to use all three variables as inputs to the decoder, every possible connection would turn off the decoder when the input is 000. The output cannot be 1 when the input is 000.

If a variable appears as a negated literal in the product term, we cannot directly use it as the input to a decoder enable.

Additional Question 5

Refer to the provided solution for Tutorial Question 4.

Can we replace the NOR gate with an OR gate with the circled decoder outputs as the inputs to the OR gate? Justify your answer.



Answer

Refer to the provided solution for Tutorial Question 4.

Can we replace the NOR gate with an OR gate with the circled decoder outputs as the inputs to the OR gate? Justify your answer.

No. There are some inputs that are supposed to be accepted but incorrectly turn off both decoders.

Consider what happens if we give 1001 as the input to the circuit.

Since B = C = 0, both decoders are disabled and all of the circled outputs are 0. m9 is incorrectly rejected.