K-MAP SIMPLIFICATION OF BOOLEAN FUNCTIONS

Experiment No. 04

This experiment demonstrates the relationship between a 'Boolean Functions' and their corresponding 'Logic Diagrams'. The Boolean functions are simplified using the 'Karnaugh Map Method'.

Activity-1. Logic Diagram

For three input variables, show that for each of the right possible input combinations, the two circuits have the identical outputs. This part of the experiment starts with a given logic diagram from which we proceed to apply simplification procedure to reduce the number of gates and possibly less hardware, i.e., less number of TTL ICs.

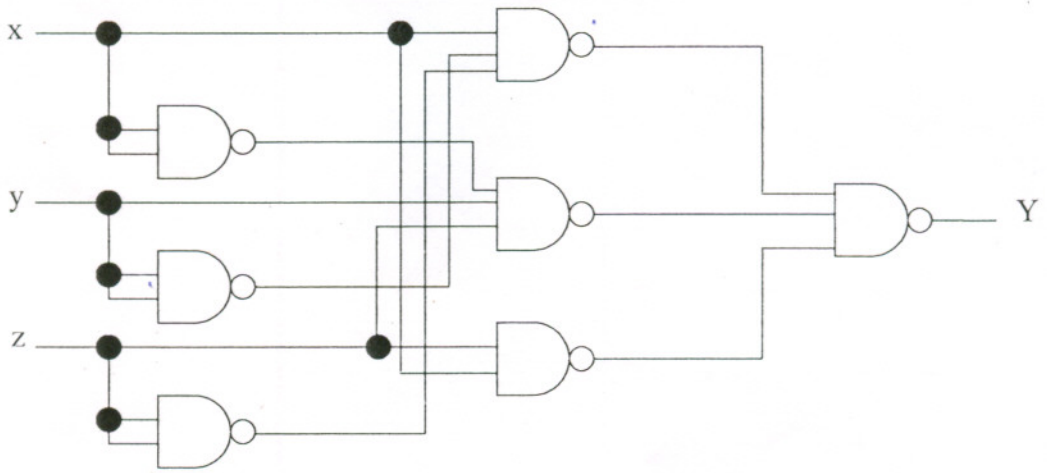


Fig. Logic diagram

The above logic diagram requires two ICs, IC7400 and IC 7410. Note that the inverters for x, y, and z are obtained from the remaining three gates in IC7400. If the inverter were taken from an IC7404, the circuit would have required three ICs 7400, 7410, and 7404, instead of two ICs 7400 and 7410. It should be avoided.

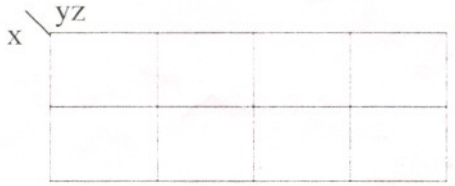
Procedure

Step1. Assign pin numbers to all inputs and outputs of the gates and connect the circuit with x, y, and z as inputs going to three switches and the output F to an indicator lamp.

Step2. Construct and test the circuit by obtaining its truth-table.

Step.3. Obtain the Boolean Function of the above circuit and simplify it using the K-map.

F(x,y,z) = ...



The simplified 'Boolean Expression' is, F(x,y,z)=.....

Observations

Truth Table

Inputs			*Outputs*	
X	*Y*	*Z*	*Original output*	*Simplified output*
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

Step.4. Construct the circuit using simplified 'Boolean Expression' without disconnecting the original circuit.

Step.5. Test both the circuits by applying identical inputs to both the circuits simultaneously and observe the separate outputs.

Step.6. Observe the 4th and 5th columns of the 'Truth-Table' you made, write your comments.

Comments

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<u>Activity-2.</u> Boolean Function

Given the 'Boolean Function' in 'Sum of Minterms' form,
F1 (A, B, C, D) = Σm(0,1,4,5,8,9,10,12,13) and
F2 (A, B, C, D) = Σm(3,5,7,8,10,11,13,15)

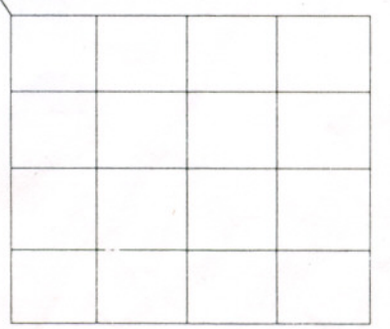
Procedure

Step.1. Simplify the two functions by means of K-map.

Function F1

Hence, F1=.....

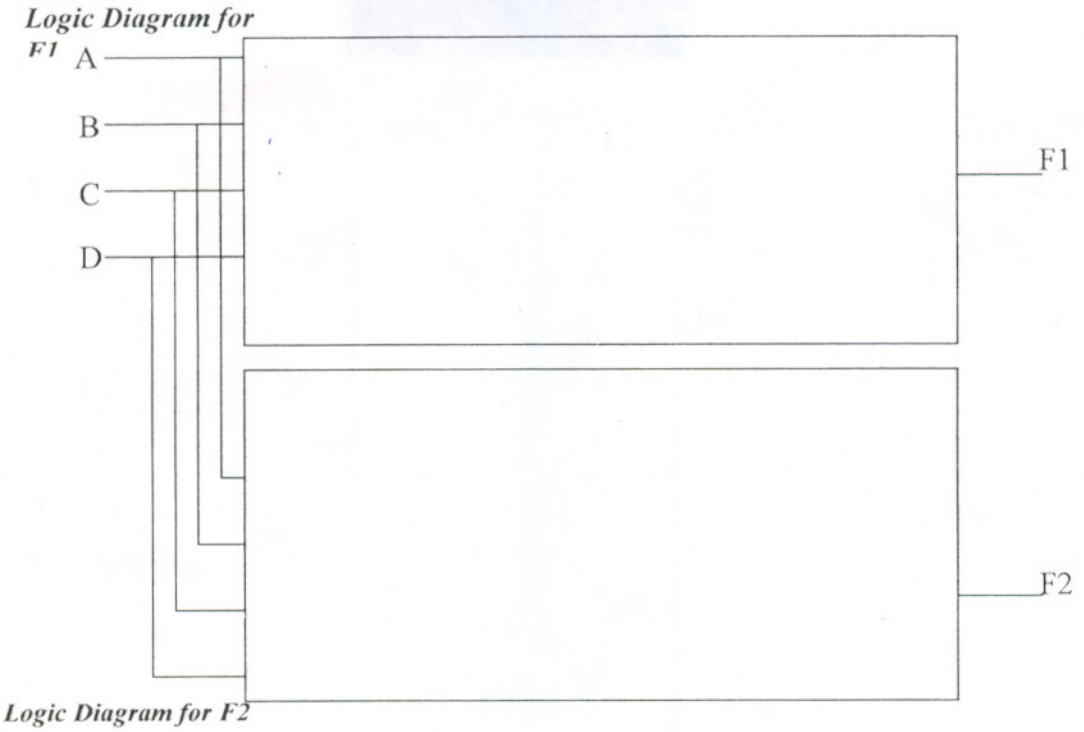
Function F2



F2=.....

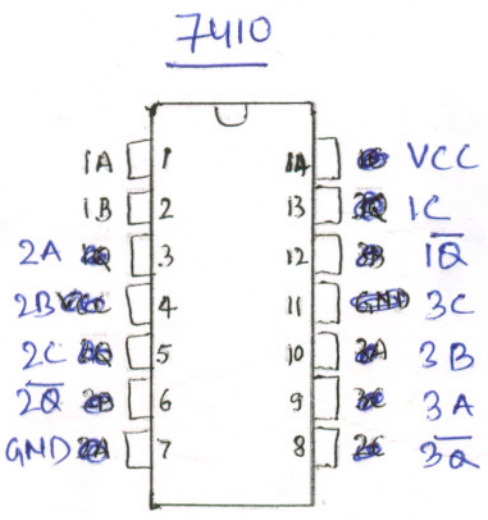
Step.2. Obtain a composite logic diagram with four inputs, A, B, C, and D, and two outputs F1 and F2. Implement the two functions together with identical inputs using a minimum number of NAND gate ICs.

Note: Don't duplicate the same gate if the corresponding term is needed for both functions. Use any extra gates in existing ICs for inverters when possible.

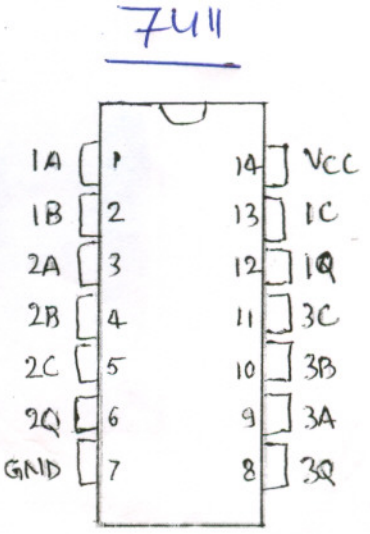


Logic Diagram for F2

Step.3. Construct the circuit and take observations.



IC Pin Diagram of 3 Input NAND Gate



IC Pin Diagram of 3 Input AND Gate

Observations

Truth-Table: For Boolean Function F1

Inputs				*Outputs*	*Given Minterm*
A	*B*	*C*	*D*	*F1*	
0	0	0	0		
0	0	0	1		
0	0	1	0		
0	0	1	1		
0	1	0	0		
0	1	0	1		
0	1	1	0		
0	1	1	1		
1	0	0	0		
1	0	0	1		
1	0	1	0		
1	0	1	1		
1	1	0	0		
1	1	0	1		
1	1	1	0		
1	1	1	1		

Truth-Table: For Boolean Function F2

Inputs				*Outputs*	*Given Minterm*
A	*B*	*C*	*D*	*F2*	
0	0	0	0		
0	0	0	1		
0	0	1	0		
0	0	1	1		
0	1	0	0		
0	1	0	1		
0	1	1	0		
0	1	1	1		
1	0	0	0		
1	0	0	1		
1	0	1	0		
1	0	1	1		
1	1	0	0		
1	1	0	1		
1	1	1	0		
1	1	1	1		

Step.4. The 'Truth-Tables' for F1 and F2 is obtained from the circuit you designed above should conform with the minterms given.

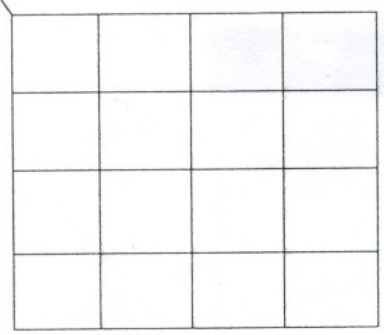
Write: whether YES/NO. .....

Activity-3. Complement Function

Step.1. Plot the following Boolean function in the K-Map,

F=A'D+BD+B'C+AB'D

Function F



Step.2. Combine 1's in the map to obtain the simplified function for F in 'Sum of Product' form.

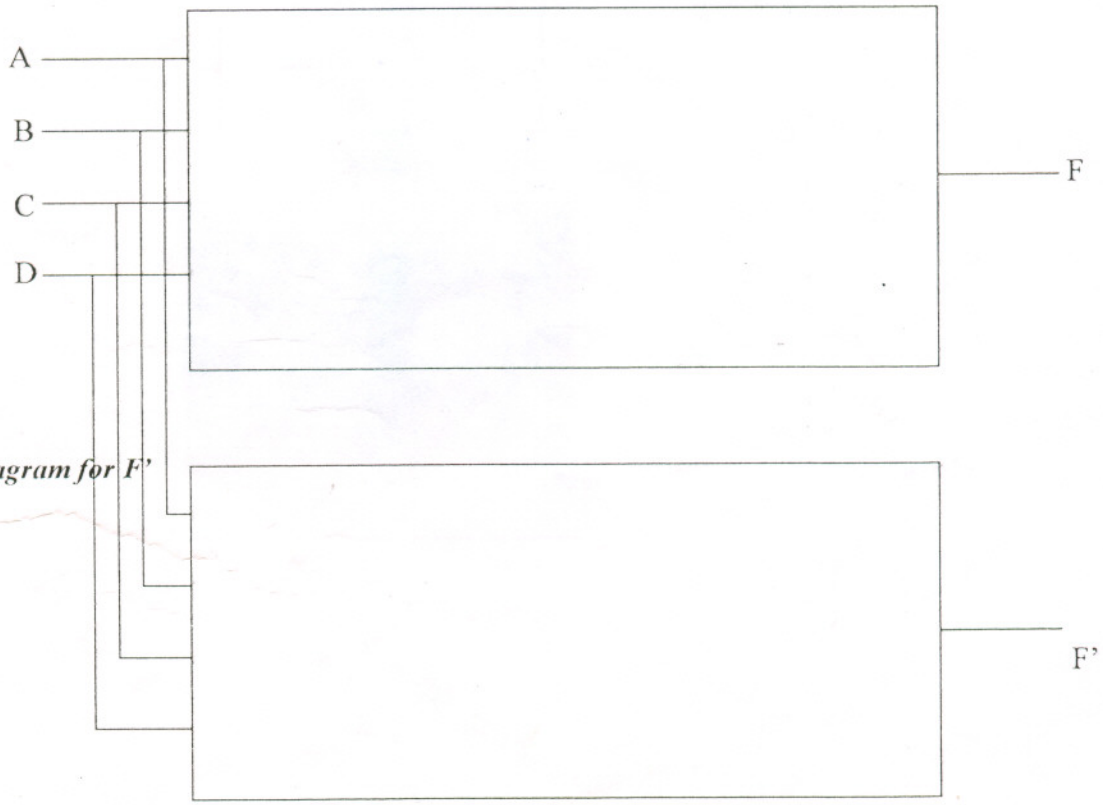
F=.....

Step.3. Combine 0's in the map to obtain the simplified function for F' in 'Product of Sum' form.

F'=.....

Step.4. Implement both the functions F and F' using only NAND gates. Connect the two circuits to the same input switches, but to separate output indicator lamps.

Logic Diagram for F



Logic Diagram for F'

Step.6. Take observations to obtain the truth-table.

Observations

Truth-Table: For Boolean Function F

Inputs				*Outputs*
A	*B*	*C*	*D*	*F*
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

Truth-Table: For Boolean Function F'

Inputs				*Outputs*
A	*B*	*C*	*D*	*F'*
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1	0	0	
1	1	0	1	
1	1	1	0	
1	1	1	1	

Step.7. By observing the truth-tables you made above , show that the functions are complement of each other. Write your comments,

Comments

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