National University of Computer and Emerging sciences

Objectives:

- To learn and understand the working of Universal gates and XOR and XNOR gates
- SOP and POS expressions from K-map with don't care condition

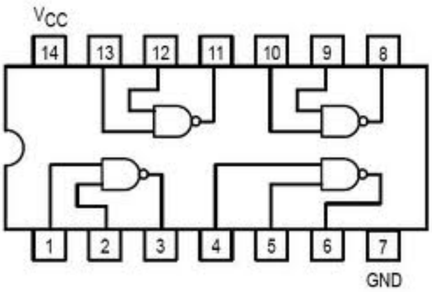
Introduction to NAND Gate

74LS00 IC contains four 2-input NAND gates. The function table and connection diagram for this IC are shown below:

Function Table

Inputs		Output
A	**B**	**Y**
L	L	H
L	H	H
H	L	H
H	H	L

Connection Diagram:



H= Logic High, L= Logic Low

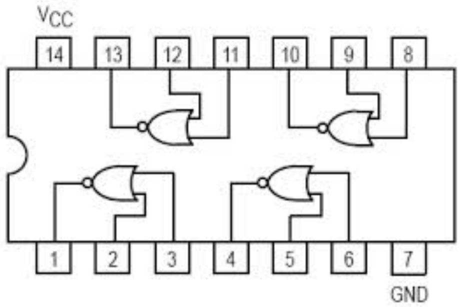
Introduction to NOR Gate

74LS02 IC contains four 2-input NOR gates. The function table and connection diagram for this IC are shown below:

Function Table:

Connection Diagram:

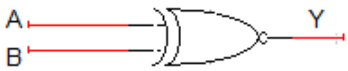
Inputs		Output
A	**B**	**Y**
L	L	H
L	H	L
H	L	L
H	H	L



H= Logic High, L= Logic Low

Exclusive-OR & Exclusive-NOR gates:

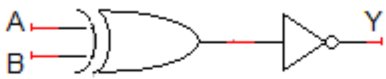
The figure given below shows the symbol of Exclusive-OR (XOR) and Exclusive-NOR (XNOR) gates.



XNOR gate

XOR gate

Boolean expression of XNOR gate is $AB + \bar{A}\bar{B}$ and Boolean expression of XOR is $\bar{A}B + A\bar{B}$. Boolean expression of XNOR gate can be implemented using XOR gate as shown in figure below:



OR

OR

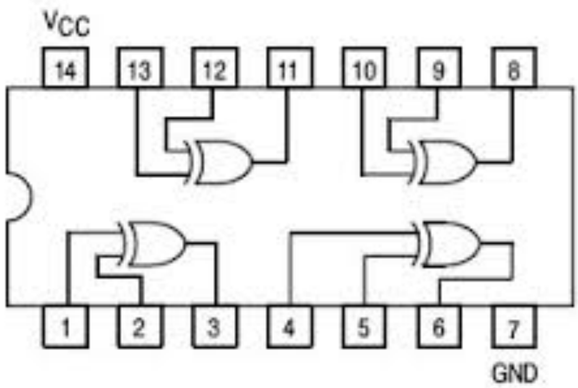
Function Table:

Inputs		**Output**
A	**B**	**Y**
L	L	L
L	H	H
H	L	H
H	H	L

H= Logic High, L= Logic Low

Connection Diagram:

74LS86 IC will be used for implementation of XOR gate function. **74LS86 IC** contains four 2-input XOR gates. The function table and connection diagram for this IC are shown below:



LAB TASK#1:

The light bulb is ON, if switch A is OFF and switch B is ON and either switch B is OFF or switch C is ON, or if switch A is ON and switch D is ON and either switch D is OFF or switch C is OFF

a) Draw the truth table for the light bulb.
b) Write Boolean function for the light bulb in canonical form using minterms.
c) Write Boolean function for the light bulb in canonical form using maxterms.
d) Find minimal SOP expression for the light bulb using K-map. Draw K-map in the space given below:
e) Fill the following table 4-1 in order to determine the gate cost for the implementation of Boolean function for the light bulb found in part (d).

IC type	Required No. of Gates	Gates per IC	Required No. of ICs

f) Find minimal POS expression for the light bulb using K-map. Draw K-map in the space
g) Fill the following table 4-2 in order to determine the gate cost for the implementation of Boolean function for the light bulb found in part (f)

IC type	Required No. of Gates	Gates per IC	Required No. of ICs

h) Find Boolean expression (mixed form) for the light bulb which is neither SOP nor POS expression
i) Fill the following table 4-3 in order to determine the gate cost for the implementation of Boolean function for the light bulb found in part (h).

IC type	Required No. of Gates	Gates per IC	Required No. of ICs

j) Implement the cost effective expression. Write the Boolean expression you have chosen to be cost effective in the space given below along with its logic diagram. Give proper reasoning for the chosen expression.

LAB TASK#2:

For the Boolean function $F1(w,x,y,z) = \sum m(0,1,2,3,7,8,10)$ with don't care condition $d(w,x,y,z) = \sum(5,6,11,15)$ do the following:

a) Find truth table

b) Find minimal **SOP** expression for Boolean function $F1$ using K-map. Draw K-map in the space given below

c) Fill the following table in order to determine the gate cost for the implementation of Boolean function $F1$ found in part (b)

IC type	Required No. of Gates	Gates per IC	Required No. of ICs
Total no. of ICs			

d) Find minimal **POS** expression for Boolean function $F1$ using K-map. Draw K-map in the space given below

e) Fill the following table in order to determine the gate cost for the implementation of Boolean function for $F1$ found in part (d)

IC type	Required No. of Gates	Gates per IC	Required No. of ICs

LAB TASK#3:

For the Boolean function $F2(A, B, C, D) = \prod M(9,13,15)$ do the following:

a) Draw the truth table

b) Find minimal SOP expression for Boolean function $F2$ using K-map. Draw K-map. Implement it using NAND gate.

c) Fill the following table 4-7 in order to determine the gate cost for the implementation of Boolean function $F2$ found in part (b)

IC type	Required No. of Gates	Gates per IC	Required No. of ICs

d) Find minimal POS expression for Boolean function $F2$ using K-map. Draw K-map.

e) Fill the following table 4-8 in order to determine the gate cost for the implementation of Boolean function for $F2$ found in part (d).

IC type	Required No. of Gates	Gates per IC	Required No. of ICs

f) Find minimal expression (mixed form) for Boolean function $F2$ which is neither SOP nor POS expression.

g) Fill the following table 4-9 in order to determine the gate cost for the implementation of Boolean function $F2$ found in part (f)

IC type	Required No. of Gates	Gates per IC	Required No. of ICs